GE Consumer & Industrial

Multilin

F650

Digital Bay Controller
User manual
GEK-113000N

Firmware version: 2.20

EnerVista F650 Setup version: 2.20

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ISO9001 REGISTERED

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To help ensure years of trouble free operation, please read through the following chapter for information to help guide you through the initial installation procedures of your new relay.

BEFORE ATTEMPTING TO INSTALL OR USE THE RELAY, IT IS IMPERATIVE THAT ALL WARNINGS AND CAUTIONS IN THIS MANUAL ARE REVIEWED TO HELP PREVENT PERSONAL INJURY, EQUIPMENT DAMAGE, AND/OR DOWNTIME.

CAUTION: THE OPERATOR OF THIS INSTRUMENT IS ADVISED THAT IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED IN THIS MANUAL, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED

Figure 1–1: FRONT VIEW OF F650 UNITS

a) COMMUNICATION BOARDS WITHDRAWAL / INSERTION

WARNING: MODULE WITHDRAWAL AND INSERTION SHALL ONLY BE PERFORMED BY DULY QUALIFIED SERVICE PERSONNEL. FOR PERSONAL SECURITY PURPOSES, BEFORE ACCOMPLISHING ANY WITHDRAWAL OR INSERTION OPERATION, THE RELAY MUST BE POWERED OFF AND ALL THE REAR TERMINALS MUST BE POTENTIAL FREE. THE RELAY MUST BE GROUNDED USING THE REAR GROUNDING SCREW.

The modular design of the relay allows withdrawal and insertion of the communication module.

Figure 1–2:: MODULE WITHDRAWAL/INSERTION shows the location of communication modules on the rear part of the relay. Skilled personnel must carry out the insertion or extraction of communication boards only after interrupting the relay auxiliary voltage and ensuring that all the rear terminals are potential free.

Communication boards are installed on the rear of the unit, the upper port being reserved for the asynchronous communications board and CAN, and the lower port for the ETHERNET board in any of its configurations.

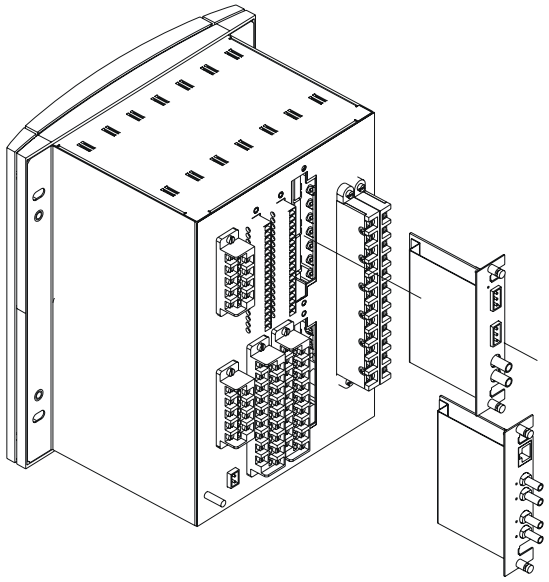

Figure 1–2: MODULE WITHDRAWAL/INSERTION

Before performing any of these actions, **control power must be removed from the relay and all the relay rear terminals must be potential free.** A grounded antistatic wristband must be used when manipulating the module in order to avoid electrostatic discharges that may cause damage to the electronic components.

WITHDRAWAL: Loose the small screws that keep the faceplate in place and extract the module.

INSERTION: Insert the module and press it firmly in the case, until it is completely fixed. After this, bolt the faceplate screws and replace the control power. Check that the relay is fully operative.

GE Multilin will not be responsible for any damage in the relay, connected equipment or personnel whenever this safety rules are not followed.

b) MAGNETIC MODULE TERMINALS

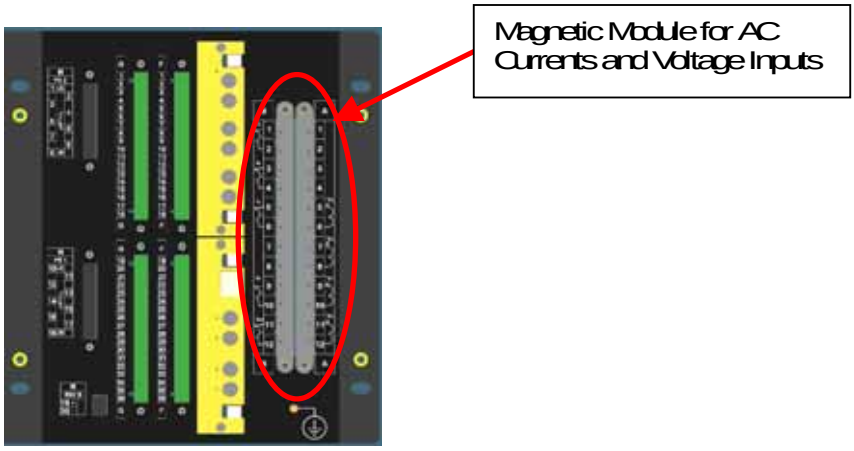

Figure 1–3: REAR VIEW OF F650 UNIT

***GE Multilin* will not be responsible for any damage in the relay, connected equipment or personnel whenever this safety rules are not followed.**

1.1.2 INSPECTION CHECKLIST

Open the relay packaging and inspect the relay for physical damage.

Refer to the label on the side of the relay verifies that the model number is the correct model ordered.

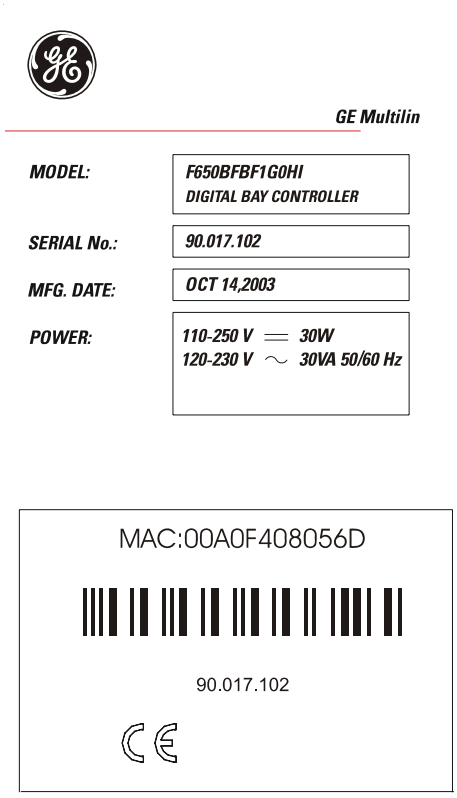

Figure 1–4: IDENTIFICATION LABEL (A4455P6)

- Please ensure that you receive the following items with your relay:

- Mounting screws for rear terminals and for fixing the relay to a cabinet
- CD containing EnerVista F650 Setup software
- Wiring diagram
- Certificate of Compliance

For product information, instruction manual updates, and the latest software updates, please visit the GE Multilin Home Page **www.geindustrial.com/multilin.**

Note: If there is any physical damage detected on the relay, or any of the contents listed are missing, please contact GE Multilin immediately at:

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The information provided herein does not intend to cover all details of variations of the equipment nor does it take into account the circumstances that may be present in your installation, operating or maintenance activities.

Should you wish to receive additional information, or for any particular problem that cannot be solved by referring to the information contained herein, please contact GENERAL ELECTRIC MULTILIN.

1.1.3 SAFETY INSTRUCTIONS

The F650 ground screw shown in Figure 1–5:: LOCATION OF GROUNDING SCREW must be correctly grounded.

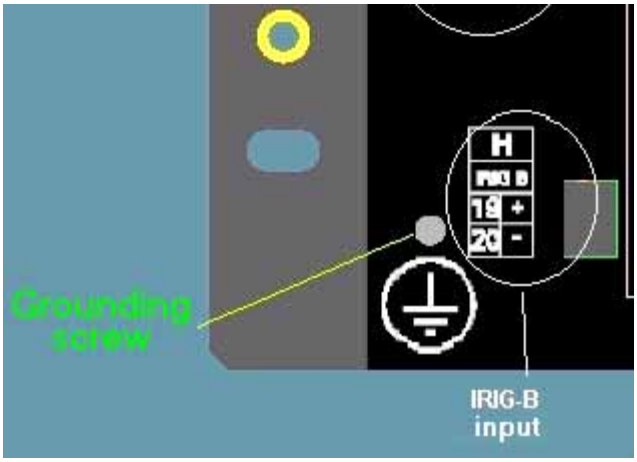


Figure 1–5: LOCATION OF GROUNDING SCREW

Before establishing the communication with a F650 unit through the front serial port, please ensure that the computer is grounded.

In case of using a laptop, it is recommended not to have it connected to its power supply. The reason for this is that in many cases it might not be correctly grounded either due to the power supply or to the connector cables used.

This is required not only for personal protection, but also for avoiding a voltage difference between the relay serial port and the computer port, which could produce permanent damage either to the computer or the relay.

***GE Multilin* will not be responsible for any damage in the relay or connected equipment whenever this elemental safety rule is not followed.**

1.2.1 INTRODUCTION TO 650 FAMILY OF RELAYS

This platform of relays has been designed to meet the goals that are appearing nowadays in the environment of new substations.

Historically, protection, control and metering functions have been performed by electromechanical elements at the beginning, then static devices, and finally by digital equipment able to integrate all these functions in a single device, called IED (Intelligent Electronic Device).

These IEDs not only must be able to perform all functions related to system protection and control, but also, using high speed communications, they must share information among them and send this information to control dispatch centers, thus reducing the quantity of auxiliary elements and wiring up to 70%.

The F650 relay belongs to this new generation of devices, and can be easily incorporated in substation automation schemes.

1.2.2 HARDWARE ARCHITECTURE

F650 units incorporate a series of interconnected modules to perform protection and control functions. Firstly, it includes a group of AC transformers for retrieving current and voltage. These magnitudes, once digitized, are sent to a digital signal processor (DSP), which performs metering functions and communicates with the main processor via a wide band bus. This architecture liberates the main processor from performing real time metering, allowing a high sampling rate, of up to 64 samples per cycle, without interfering with global performance.

F650 relays are digital devices that include a CPU that can control multiple types of input and output signals.

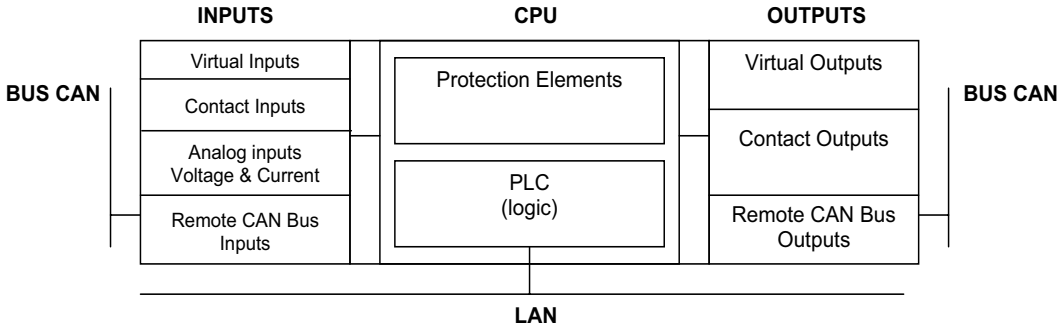


Figure 1–6: F650 CONCEPT BLOCK DIAGRAM

Contact Inputs/Outputs are signals associated to physical input/output contacts in the relay

Analog Inputs are signals coming from the inputs of current and voltage transformers, used for monitoring the power system signals.

Remote CAN Bus Inputs/Outputs: are signals associated to physical input/output contacts from independent modules connected to the 650 unit via a fiber optic CAN Bus.

PLC: Programmable Logic Controller. Control module that enables the unit configuration (assignment of inputs/outputs) and the implementation of logic circuits.

Protection Elements: Relay protection elements, for example: Overcurrent, overvoltage, etc.

1.2.3 SOFTWARE ARCHITECTURE

The firmware (software embedded in the relay) has been designed using object oriented programming techniques (OOP). These techniques are based on the use of objects and classes, and provide the software architecture with the same characteristics as the hardware architecture, i.e., modularity, scalability and flexibility.

1.2.4 COMMUNICATIONS ARCHITECTURE

The main processor performs protection, control, and communication functions, incorporating two internal processors, one for generic use and a second one dedicated for communications.

A dedicated serial port is used for communication between the main processor and the human-machine interface. Serial connection provides great immunity against electromagnetic disturbances, thus increasing system safety.

All F650 units incorporate an RS232 serial port on the front of the relay. There is also a possibility to incorporate up to two additional communication modules on the rear.

One of the modules provides asynchronous serial communications, using different physical media (RS485, plastic or glass fiber optic) depending on the selected model. The module incorporates two identical ports, COM1 and COM2. COM2 port is multiplexed with the front port. Additionally, this module may incorporate a glass fiber optic port for CAN BUS communications, used for the connection to the Remote CAN BUS I/O module. This feature allows increasing up to 100% the I/O capability, when the maximum number of I/Os available inside the relay (up to 32 inputs and 16 outputs) is not enough for a specific application.

Available options are:

Table 1–1: TABLE 1-1 REAR SERIAL COMMUNICATIONS BOARD 1

Board Code	Functionality
F	Without additional communication ports
A	Two RS485 ports
P	Two Plastic F.O. ports
G	Two Glass F.O. ports
X	Two RS485 ports and a CAN port for remote CAN Bus Inputs/Outputs
Y	Two Plastic F.O. ports and a CAN port for remote CAN Bus Inputs/Outputs
Z	Two Glass F.O. ports and a CAN port for remote CAN Bus Inputs/Outputs

The other module provides Ethernet communications (COM3 port), using 10/100BaseTX (self-negotiable speed) or 100BaseFX connectors, depending on the selected model. Most complete models include a double redundant 100BaseFX fiber optic port. Redundancy is provided at a physical media level; the unit incorporates internally duplicated and independent controllers for extended system reliability and accessibility.

Available Options are:

Table 1–2: REAR ETHERNET COMMUNICATIONS BOARD 2

Board Code	Functionality
B	One 10/100BaseTX port (self-negotiable speed)
C	One 10/100BaseTX port and one 100BaseFX port.
D	One 10/100BaseTX port and two 100BaseFX ports

For options C and D it is required to select the active physical media, by means of an internal selector inside the module. The factory configuration for this selection is the 10/100BaseTX port.

Finally, internal communication with input and output modules is performed via an internal CAN bus, independent from the one used for remote CAN BUS I/Os. This fact provides increased communication speed, as well as the possibility of acknowledgement of modules, abnormalities, etc. As this is a serial port supporting a communications protocol, it provides extraordinary immunity against external or internal disturbances.

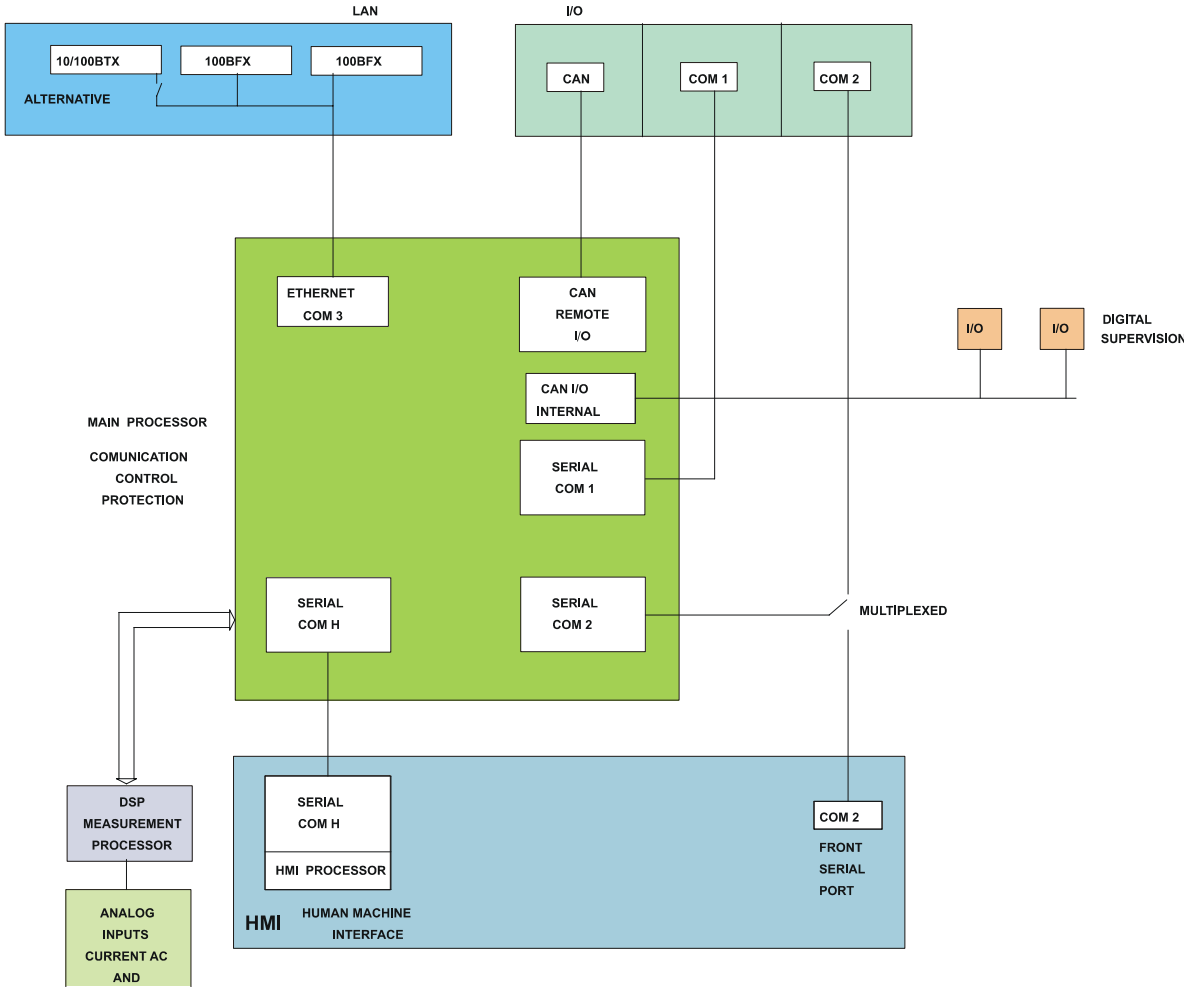


Figure 1–7: COMMUNICATIONS ARCHITECTURE (B6816F1)

1.3.1 SYSTEM REQUIREMENTS

The EnerVista F650 Setup software interface is the preferred method to edit settings and view actual values because the PC monitor can display more information in a simple comprehensible format.

The following minimum requirements must be met for the EnerVista F650 Setup software to properly operate on a PC:

- Pentium® class or higher processor (Pentium® II 300 MHz or higher recommended)
- Windows® NT 4.0 (Service Pack 3 or higher), Windows® 2000, Windows® XP
- Internet Explorer® 5.0 or higher
- 64 MB of RAM (128 MB recommended)
- 40 MB of available space on system drive and 40 MB of available space on installation drive
- RS232C serial and Ethernet port for communications to the relay

1.3.2 INSTALLATION

After ensuring the minimum requirements for using EnerVista F650 Setup are met (see previous section), use the following procedure to install the EnerVista F650 Setup from the GE EnerVista CD.

1. Insert the GE EnerVista CD into your CD-ROM drive.
2. Click the **Install Now** button and follow the installation instructions to install the no-charge EnerVista software.
3. When installation is complete, start the EnerVista Launchpad application.
4. Click the **IED Setup** section of the **Launch Pad** window.

Figure 1–8: LAUNCHPAD WINDOW

5. In the EnerVista Launch Pad window, click the **Add Product** button and select the “F650 Bay Controller” relay from the Install Software window as shown below. Select the “Web” option to ensure the most recent software release, or select “CD” if you do not have a web connection, then click the **Add Now** button to list software items for the F650.

Figure 1–9: ADD PRODUCT WINDOW

6. If “Web” option is selected, chose the F650 software program and release notes (if desired) from the list and click the **Download Now** button to obtain the installation program.

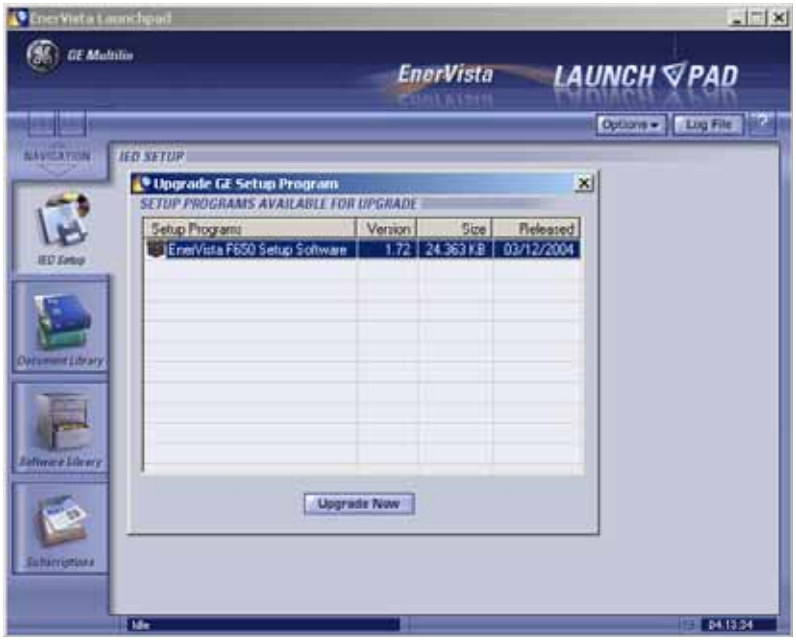


Figure 1–10: WEB UPGRADE WINDOW

7. EnerVista Launchpad will obtain the installation program from the Web or CD. Once the download is complete, double-click the installation program to install the EnerVista F650 Setup software.
8. Select the complete path, including the new directory name, where the EnerVista F650 Setup will be installed.

9. Click on **Next** to begin the installation. The files will be installed in the directory indicated and the installation program will automatically create icons and add EnerVista F650 Setup to the Windows start menu.
10. Follow the on-screen instructions to install the EnerVista F650 Setup software. When the **Welcome** window appears, click on **Next** to continue with the installation procedure.

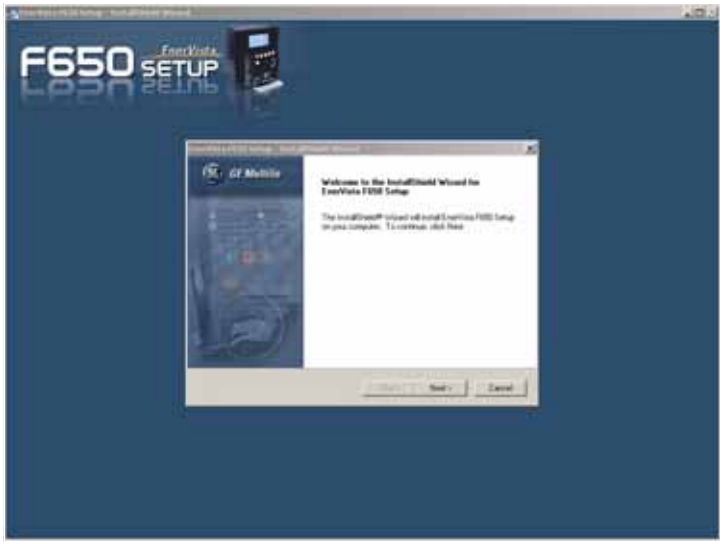


Figure 1–11: ENERVISTA F650 SETUP INSTALLATION

11. When the **Choose Destination Location** window appears, and if the software is not to be located in the default directory, click **Change…** and type in the complete path name including the new directory name and click **Next** to continue with the installation procedure.

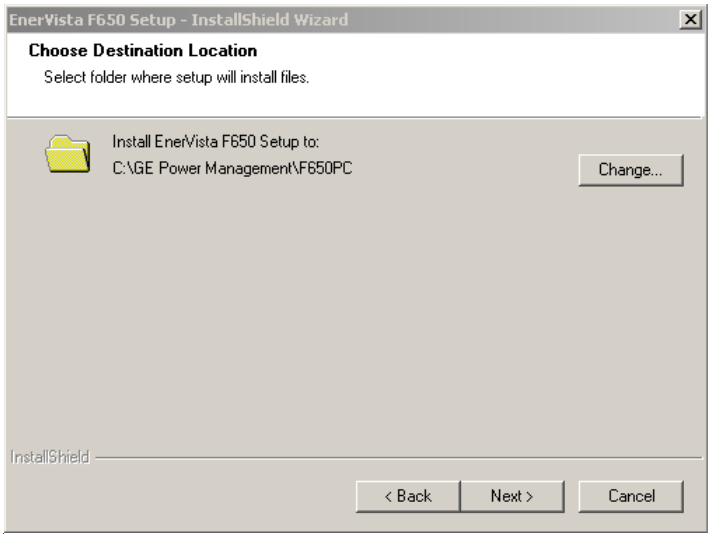


Figure 1–12: ENERVISTA F650 SETUP INSTALLATION CONT.

12. The default program group where the application will be added to is shown in the **Selected Program Folder** window. Click Next to begin the installation process, and all the necessary program files will be copied into the chosen directory.

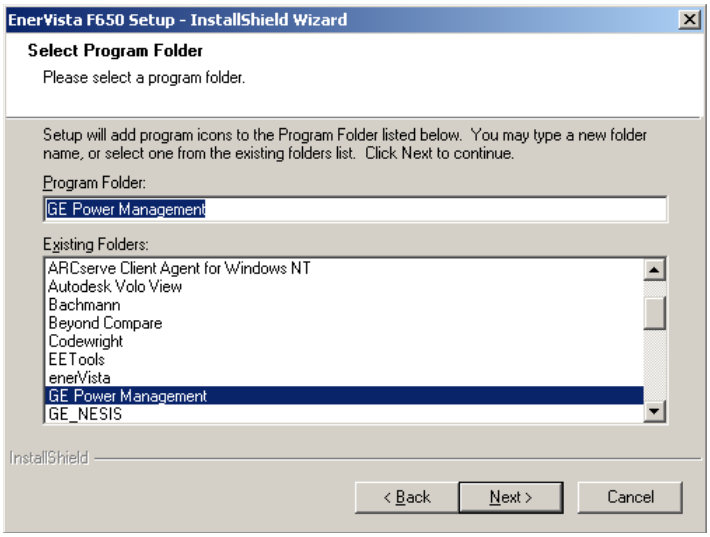

EnerVista F650 Setup - InstallShield Wizard
Select Program Folder
Please select a program folder.
Setup will add program icons to the Program Folder listed below. You may type a new folder name, or select one from the existing folders list. Click Next to continue.
Program Folder:
GE Power Management
Existing Folders:
ARCserve Client Agent for Windows NT
Autodesk Volo View
Bachmann
Beyond Compare
Codewright
EETools
enerVista
GE Power Management
GE_NESIS
InstallShield
< Back
Next >
Cancel

Figure 1–13: SELECT PROGRAM FOLDER

13. To finish with the installation process, select the desired language for startup.

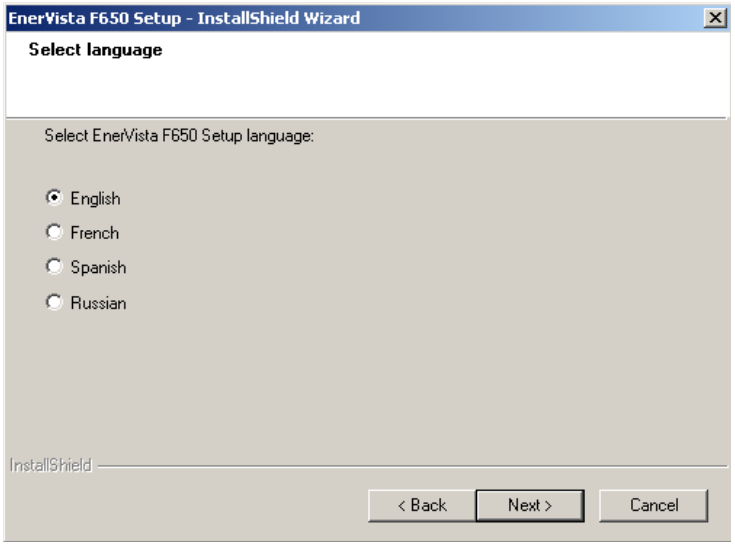


Figure 1–14: LANGUAGE WINDOW

14. Click **Finish** to end the installation. The F650 device will be added to the list of installed IEDs in the EnerVista Launchpad window, as shown below.

Figure 1–15: ENERVISTA LAUNCHPAD

1.3.3 CONNECTING WITH THE UNIT

This section is intended as a quick start guide to using the EnerVista F650 Setup software. Please refer to section 4.1 in this manual for more information about the EnerVista F650 Setup software interface.

a) CONFIGURING AN ETHERNET CONNECTION

Before starting, verify that the Ethernet network cable is properly connected to the Ethernet port on the back of the relay.

1. Install and start the latest version of the EnerVista F650 Setup software (available from the GE EnerVista CD or online from http://www.GEindustrial.com/multilin (see previous section for installation instructions).
2. Go to "***Communication>Computer***" and enter the following data referred to communications:
3. Select Control Type as MODBUS TCP/IP from the drop-down list. This option will display a number of interface parameters that must be entered for proper Ethernet communications.
4. Enter the relay IP address (from "***Setpoint>Product Setup >Communication Settings>Network>IP ADDRESS***") in the IP Address field in MODBUS TCP/IP SETUP.
5. Enter the relay ModBus address (from "***Setpoint>Product Setup >Communication Settings>ModBus Protocol>ModBus Address COM1/COM2 setting***") in the Unit Identifier (Slave Address) field.
6. Enter the ModBus port address (from "***Setpoint>Product Setup >Communication Settings>ModBus Protocol>ModBus Port Number***" setting) in the ModBus Port field.
7. The Device has now been configured for Ethernet communications. Proceed to press the ON button to begin communicating.

b) CONFIGURING AN RS232 CONNECTION

Before starting, verify that the RS232 serial cable is properly connected to the RS232 port on the front panel of the relay.

1. Install and start the latest version of the EnerVista F650 Setup software (available from the GE EnerVista CD or online from http://www.GEindustrial.com/multilin (see previous section for installation instructions).
2. Go to "***Communication>Computer***" and enter the following data referred to communications:
3. Select Control Type as No Control Type from the drop-down list. This option will display a number of interface parameters that must be entered for proper serial communications.
4. Enter the relay Slave Address ("***Setpoint>Product Setup >Communication Settings>ModBus Protocol***" menu) in the Slave Address field.
5. Enter the physical communications parameters (Baudrate and parity settings) from ***"Setpoint>Product Setup >Communication Settings>Serial Ports***" menu, in their respective fields.
6. The Device has now been configured for RS232 communications. Proceed to press the ON button to begin communicating.

1.3.4 COMMUNICATIONS

To communicate with the relay via the faceplate RS232 port, a standard "straight through" serial cable is used. The DB9 male end is connected to the relay and the DB9 or DB25 female end is connected to the PC COM1 or COM2 port as described in the figure below.

Direct connection to the Ethernet port will be carried out using a crossover cable. If this connection is performed through a hub or switch, we will use direct Ethernet cable.

To communicate with the relay rear RS485 port from a computer RS232 port, an RS232/RS485 converter box is needed. We recommend using the F485 converter, manufactured by GE. This converter box is connected to the computer using a straight through serial cable. A shielded twisted pair (20, 22 or 24 AWG according to the American standards; 0.25, 0.34 or 0.5 mm^2 according to the European standards) cable is used to connect the converter box to the relay rear communications terminals. In order to minimize communication errors that could be caused by external noise, it is recommended to use a shielded twist pair. In order to avoid loops where external currents could flow, the cable shield must be grounded only at one end.

The converter box (-, +, GND) terminals are connected to the relay (SDA, SDB, GND) terminals respectively. For long communications cables (longer than 1 km), the RS485 circuit must be terminated in a RC network (i.e. 120 ohm, 1 nF). This circuit is shown on Figure 1–17:: RS485 CONNECTION FOR F650 UNITS, associated to text Zt(*).

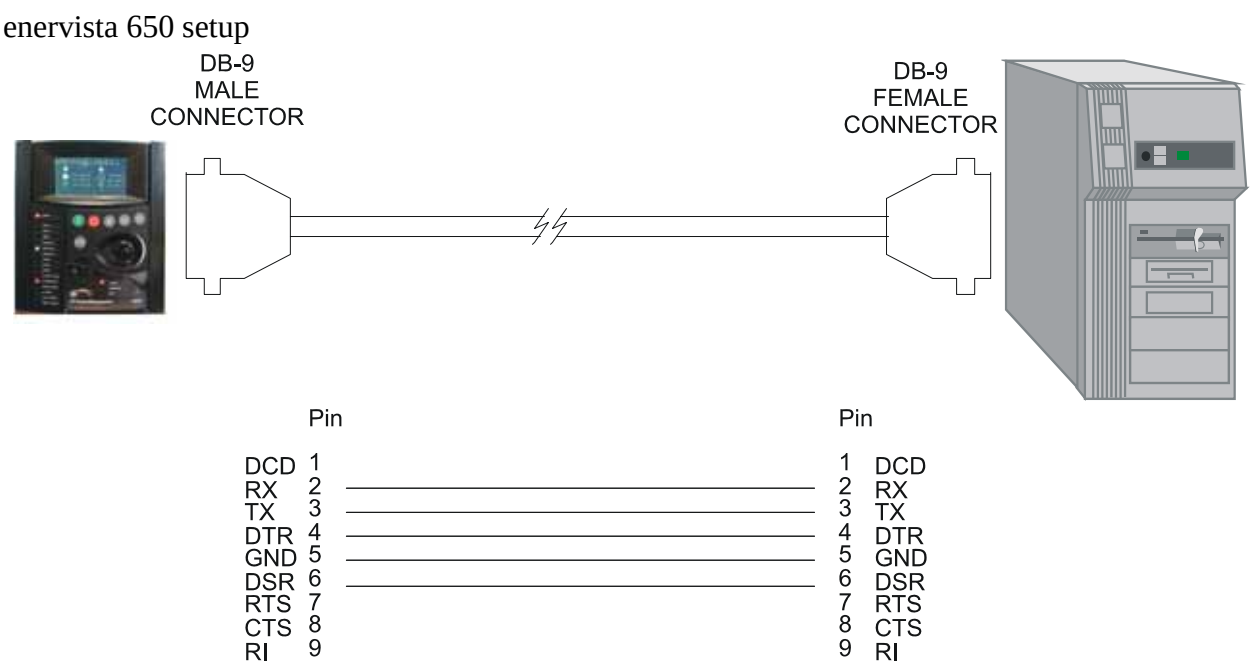


Figure 1–16: RELAY- PC CONNECTION FOR RS232 FRONT PORT

To minimize errors from noise, the use of shielded twisted pair wire is recommended. For a correct operation, polarity must be respected, although if it is not so, there is no danger to damage the unit. For instance, the relays must be connected with all RS485 SDA terminals connected together, and all SDB terminals connected together. This may result confusing sometimes, as the RS485 standard refers only to terminals named “A” and “B”, although many devices use terminals named “+” and “-“.

As a general rule, terminals “A” should be connected to terminals “-“, and terminals “B” to “+”. The GND terminal should be connected to the common wire inside the shield, when provided. Otherwise, it should be connected to the shield. Each relay should also be daisy chained to the next one in the link. A maximum of 32 relays can be connected in this manner without exceeding driver capability. For larger systems, additional serial channels must be added. It is also possible to use commercially available repeaters to increase the number of relays on a single channel to more than 32. Do not use other connection configuration different than the recommended.

Lightning strikes and ground surge currents can cause large momentary voltage differences between remote ends of the communication link. For this reason, surge protection devices are internally provided. To ensure maximum reliability, all equipment should have similar transient protection devices installed.

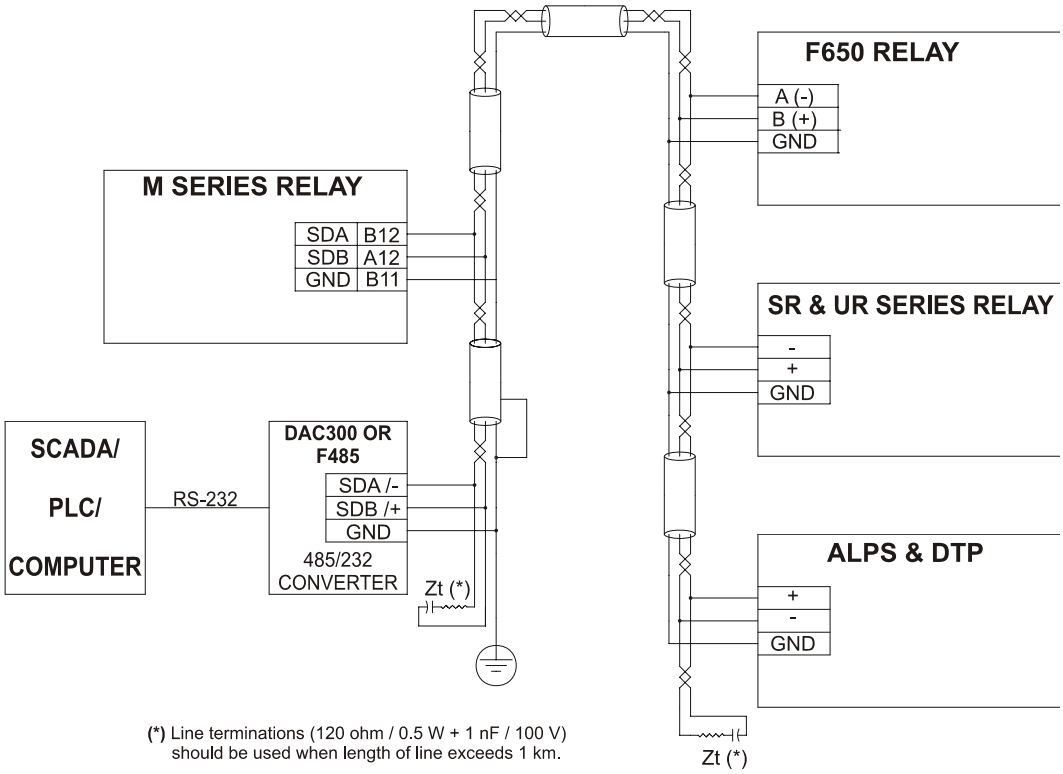


Figure 1–17: RS485 CONNECTION FOR F650 UNITS

2.1.1 F650 OVERVIEW

The F650 is a protection, control, monitoring, metering and registering unit, suitable for many different applications, such as main protection for distribution feeders and transmission lines, as well as backup protection for transformers, busbars, capacitor banks, etc. The main features of F650 devices include:

- Directional overcurrent protection for phases, neutral, ground and sensitive ground
- Under and overvoltage protection
- Under and overfrequency protection
- Autorecloser
- Synchronism
- Metering
- Oscillography registers, fault reports, data logger
- Bay control (open/close commands, etc.)
- Bay mimic.
- Communications (RS232/RS485/fibre optic/Ethernet)
- Fully programmable front buttons, 15 LED's and input/output contacts

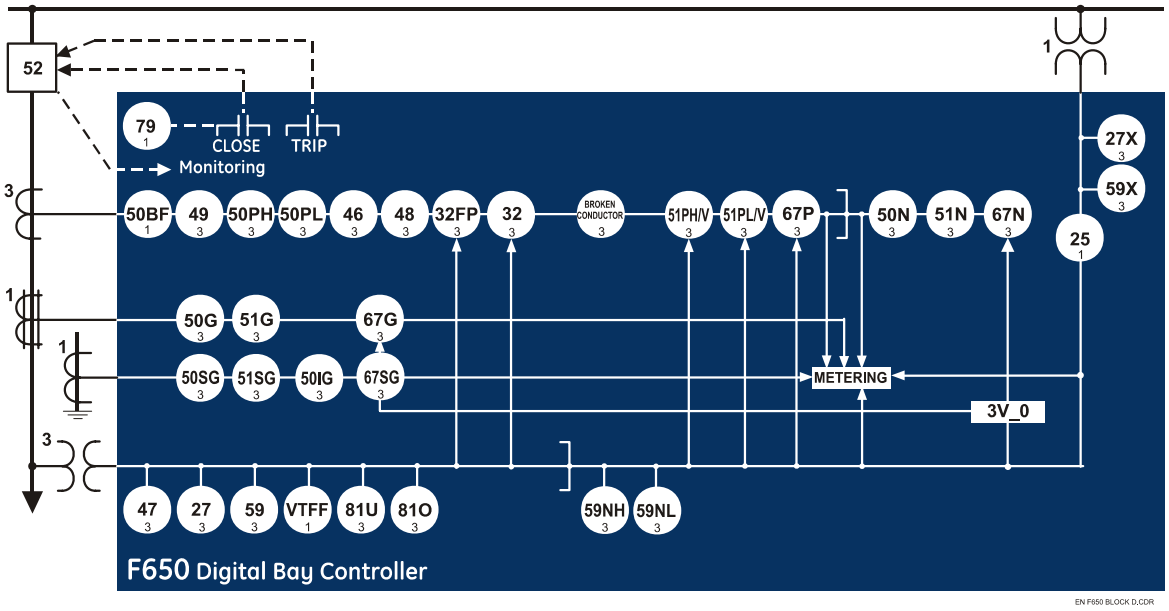


Figure 2–1: FUNCTIONAL BLOCK DIAGRAM

2.2.1 ANSI DEVICE NUMBERS AND FUNCTIONS

DEVICE NUMBER	FUNCTION
25	Synchronism
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
32	Sensitive Directional Power
32FP	Forward Power
46	Negative Sequence Time Overcurrent
47	Negative Sequence Overvoltage
48	Locked Rotor
49	Protection against Overload by thermal model
50G	Ground Instantaneous Overcurrent (measured from 4th current transformer)
50N	Neutral Instantaneous Overcurrent (calculated from the phase currents)
50P	Phase Instantaneous Overcurrent (two elements, High and Low)
50SG	Ground Instantaneous Overcurrent for sensitive ground systems (measured from 5th current transformer)
50ISG	Isolated Ground Instantaneous Overcurrent (measured from 5th current transformer)
51G	Ground Time Overcurrent (measured from 4th current transformer)
51N	Neutral Time Overcurrent (calculated from the phase currents)

DEVICE NUMBER	FUNCTION
51PV	Phase Time Overcurrent with Voltage Restraint (two elements, High and Low)
51SG	Ground Time Overcurrent for sensitive ground systems (measured from 5th current transformer)
59N	Neutral Overvoltage (two elements, High and Low)
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
67P	Phase Directional
67N	Neutral directional
67G	Ground Directional
67SG	Sensitive Ground Directional
79	Automatic Recloser (Four shot recloser)
810	Overfrequency
81U	Underfrequency
I2/I1	Broken Conductor
50BF	Breaker Failure
VTFF	VT Fuse Failure

Table 2–1: OTHER DEVICE FUNCTIONS

INPUTS/OUTPUTS	METERING	COMMUNICATIONS
9 Analog Inputs: 5 current inputs (3 for phases, 1 for ground, 1 for sensitive ground), 4 voltage inputs (3 for phases, 1 for busbar or auxiliary voltage)	Metering Current for phases, ground and sensitive ground inputs	Front RS232 port, Two rear RS485/fibre optic ports, 10/100 TX and 100 FX Mbps Ethernet port
Digital Programmable Contact Inputs (up to 32)	Voltages phase to phase and phase to ground	ModBus Communications RTU and over TCP/IP
Digital Programmable Contact Outputs (up to 16)	Real, Reactive and Apparent Power and Power Factor	DNP Multimaster (3.0 Level 2)
32 Latched Virtual Inputs 32 Self-Reset Virtual Inputs	Three Phase Energy	IEC 870-5-104
Virtual Outputs (up to 512)	Frequency	ModBus User Map
Tripping and closing circuit supervision	Sequence components of currents and voltages	

USER INTERFACE
Alphanumerical display (4x20)
Graphic display (16 x 40)
User Programmable LEDs (15)
User Programmable Keys (up to 5)
Easy menu management thanks to shuttle key
Configurable One-Line Diagram (Graphic model only)
Phasor Diagram (available in EnerVista F650 Setup)

RECORDS
Data Logger
Demand
Event Recorder (up to 128 configurable events)
Fault Locator and Fault report (up to 10 records)
Oscillography (up to 20 records)
Snapshot Events (up to 479)

OTHERS
Breaking Arcing Current (I2t)
Breaker Control
IRIG-B synchronization
Logic Equations (PLC Editor)
Settings Groups (up to 3)
Operations (up to 24)
Web Server Application

F650 units are supplied as ½ 19" rack, 6 units high devices, containing the following modules: power supply, CPU, I/O modules, communication modules. Each of these modules can be supplied in different versions that must be specified when ordering. The required information to completely define an F650 model is shown on TABLE 2-1.

Table 2–2: ORDERING CODE

F650	-	-	-	F	-	G	-	-		DESCRIPTION
	B									Basic display (4x20 characters)
	M									Graphic display (240x128 pixels)
										REAR SERIAL COMMUNICATIONS BOARD 1
		F								None
		A								Redundant RS485
		P								Redundant plastic fiber optic
		G								Redundant glass fiber optic
		X								Redundant RS485 + fiber remote CAN bus I/O
		Y								Redundant plastic fiber optic + fiber remote CAN bus I/O
		Z								Redundant glass fiber optic + fiber remote CAN bus I/O
		C								Cable remote CAN Bus I/O
		M								RS485 + cable remote CAN Bus I/O
										REAR ETHERNET COMMUNICATIONS BOARD 2
			B							10/100 Base TX
			C							10/100 Base TX + 100 Base FX
			D							10/100 Base TX + Redundant 100 Base FX
			E							Redundant 10/100 Base TX
										I/O BOARD IN SLOT F
					1					16 Digital Inputs + 8 Outputs
					2					8 Digital Inputs - 8 Outputs + 2 trip/close circuit supervision circuits
										I/O BOARD IN SLOT G
							0			None
							1			16 Inputs + 8 Outputs
										AUXILIARY VOLTAGE
								LO		24-48 Vdc (range 19.2 – 57.6)
								HI		110-250 Vdc (range 88 – 300) 120-230 Vac (range 96 – 250)
								LOR		Redundant LO
								HIR		Redundant HI
										LANGUAGE
										English/English
									F	French/English
									P	Russian/English (*)
									S	Spanish/English

SPECIAL MODELS: MOD001: 6A output contacts instead of 16A.

(*) Note: Russian language available only for basic display models.

For those applications requiring a high number of inputs and outputs, F650 units can be connected to a CIO module (Remote CAN Bus I/O module) for using up to 2 additional boards.

F650 units allow monitoring and configuring these I/O boards as if they were internal boards, located on slots F and G. In this case, slots are labeled as H y J.

The required information to completely define a CIO Module is shown on TABLE 2-2.

Table 2–3: ORDERING CODE FOR CIO MODULE

CIO	H	-	J	-	-	DESCRIPTION
						I/O BOARD IN SLOT H
		1				16 inputs + 8 outputs
		2				8 inputs + 4 circuit supervision circuits + 6 outputs + 2 outputs with tripping current supervision (latching)
						I/O BOARD IN SLOT J
				0		None
				1		16 inputs + 8 outputs
				2		8 inputs + 4 circuit supervision circuits + 6 outputs + 2 outputs with tripping current supervision (latching)
						AUXILIARY VOLTAGE
					LO	24-48 Vdc (range 19.2 – 57.6)
					HI	110-250 Vdc (range 88 – 300) 120-230 Vac (range 96 – 250)

NOTE: TECHNICAL SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

2.4.1 PROTECTION UNITS

Phase and ground units use as operation magnitude the current value received by the unit in current inputs, while the neutral unit uses the calculated current value from the three phase currents.

The isolated ground unit will be used only for those applications where the neutral is completely isolated, and it uses the fifth CT of the unit. This CT has a sensitivity that is 10 times higher than the universal model (connected to 1A or 5A transformers). Therefore, it does not admit such a high permanent overload.

a) PHASE TIME OVERCURRENT WITH VOLTAGE RESTRAINT (51PH/51PL)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	98% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3.5% of operate time or 30 ms. (whichever is greater)
Voltage restraint	Selectable by setting
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

b) GROUND TIME OVERCURRENT (51G)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	98% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.

Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3.5% of operate time or 30 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

c) NEUTRAL TIME OVERCURRENT (51N)

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	98% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3.5% of operate time or 30 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

d) SENSITIVE GROUND TIME OVERCURRENT (51SG)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.005 to 16.000 A in steps of 0.001 A
Reset level	98% of the pickup level
Level Accuracy	±1.5% of the reading ± 1 mA from 0.005 to 16 A

Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3.5% of operate time or 30 ms. (whichever is greater)
Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

e) PHASE AND GROUND INSTANTANEOUS OVERCURRENT (50PH/50PL/50G)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	97% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
Overreach	< 2%
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	±3% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

f) NEUTRAL INSTANTANEOUS OVERCURRENT (50N)

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.00 A in steps of 0.01 A
Reset level	97% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
Overreach	< 2%
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	±3% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

g) SENSITIVE GROUND INSTANTANEOUS OVERCURRENT (50SG)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.005 to 16.000 A in steps of 0.001 A
Reset level	97% of the pickup level
Level Accuracy	±1.5% of the reading ± 1 mA from 0.005 to 16 A
Overreach	< 2%
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz
Timing accuracy	±3% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

h) ISOLATED GROUND INSTANTANEOUS OVERCURRENT (50IG)

Current Input	Fundamental Phasor (without harmonics)
Voltage Input	Fundamental Phasor (without harmonics)
Current Pickup level	0.005 to 0.400 A in steps of 0.001 A
Voltage Pickup level	2 to 70 V in steps of 1 V
Reset level	97-98% of the pickup level
Level Accuracy	±1.5% of the reading ± 1 mA from 0.005 to 16 A
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Time to instantaneous	0.00 to 900.00 s. in steps of 0.01 s.
Timing accuracy	±3% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

i) NEGATIVE SEQUENCE (46)

Current Input	Fundamental Phasor (without harmonics)
Pickup level	0.05 to 160.0 A in steps of 0.01 A
Reset level	98% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
Curve Shapes	IEEE extremely / very / moderately inverse IEC A/B/C/long-time inverse/short time inverse curve IAC extremely / very / normally / moderately inverse ANSI extremely / very / normally / moderately inverse I^2t Definite time Rectifier curve FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial)	0.00 to 900.00 s in steps of 0.01 s
Reset type	Instantaneous or time delayed according to IEEE
Timing accuracy	Operate at > 1.03 times the pickup ±3.5% of operate time or 30 ms. (whichever is greater)

Saturation Level	48 times the pickup level
Snapshot Events	Selectable by setting

j) PHASE DIRECTIONAL (67P)

Directionality	Forward and reverse selectable by setting
Polarizing	Quadrature Voltage: ABC seq: Phase A (VBC), Phase B (VCA), Phase C (VAB) ACB seq: Phase A (VCB), Phase B (VAC), Phase C (VBA)
Polarizing voltage threshold	0 to 300 Vac in steps of 1 V
Characteristic angle	-90º to +90º in steps of 1º
Block Logic	Permission or Block selectable by setting
Angle accuracy	±2º for I>0.1 A and V>5 Vac
Operate time	<30ms, typically

k) GROUND DIRECTIONAL (67G)

Directionality	Forward and reverse selectable by setting
Polarizing	Voltage, current, dual
Polarizing Voltage	V_N (measured or calculated, selected by setting)
Polarizing Current	Isg (measured from 5th current transformer)
Operating Current	Ig (measured from 4th current transformer)
Polarizing Voltage threshold	0 to 300 Vac in steps of 1 V
Polarizing Current threshold	0.005 A
Characteristic angle	-90º to +90º in steps of 1º
Block Logic	Permission or Block selectable by setting
Angle accuracy	±2º for I>0.1 A and V>5 Vac
Operate time	<30ms, typically

l) NEUTRAL DIRECTIONAL (67N)

Directionality	Forward and reverse selectable by setting
Polarizing	Voltage, current, dual
Polarizing Voltage	V_N (measured or calculated, selected by setting)
Polarizing Current	Isg (measured from 5th current transformer)
Operating Current	I_N
Polarizing Voltage threshold	0 to 300 Vac in steps of 1 V
Polarizing Current threshold	0.005 A
Characteristic angle	-90º to +90º in steps of 1º
Block Logic	Permission or Block selectable by setting

Angle accuracy	±2º for I>0.1 A and V>5 Vac
Operate time	<30ms, typically

m) SENSITIVE GROUND DIRECTIONAL (67SG)

Directionality	Forward and reverse selectable by setting
Polarizing	Voltage
Polarizing Voltage	V_N (measured or calculated, selected by setting)
Operating Current	Isg (measured from 5th current transformer)
Polarizing Voltage threshold	0 to 300 Vac in steps of 1 V
Characteristic angle	-90º to +90º in steps of 1º
Block Logic	Permission or Block selectable by setting
Angle accuracy	±2º for I>0.1 A and V>5 Vac
Operate time	<30ms, typically

n) THERMAL MODEL (49)

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level	0.05 to 160.0 A in steps of 0.01 A
Reset level	97% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Heating constant	Between 3 and 600 minutes
Cooling constant	1 to 6 times the heating constant
Snapshot Events	Selectable by setting

o) PHASE OVERVOLTAGE (59P)

Voltage Input	Fundamental Phasor (without harmonics) of phase-to-phase voltages
Pickup level	3 to 300 in steps of 1 V
Reset level	97% of the pickup level
Level Accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Logic	Any/Two/All phases logic selectable by setting
Snapshot Events	Selectable by setting

p) PHASE UNDERVOLTAGE (27P)

Voltage Input	Fundamental Phasor of phase-to-ground or phase-to-phase voltages (selectable by setting)
Pickup level	3 to 300 in steps of 1 V
Reset level	103% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V
Curve Shapes	Fixed time or inverse curve
Reset type	Instantaneous
Curve Multiplier (Time Dial)	0.00 to 900.00 s. in steps of 0.01 s.
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Minimum Voltage Threshold	0 to 300 in steps of 1 V
Logic	Any/Two/All phases logic selectable by setting
Supervised by Breaker	Selectable by setting
Snapshot Events	Selectable by setting

q) NEUTRAL OVERVOLTAGE (59NH/59NL)

Voltage Input	Fundamental Phasor of the neutral voltage
Pickup level	3 to 300 in steps of 1 V
Reset level	97% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

r) NEGATIVE SEQUENCE OVERVOLTAGE (47)

Voltage Input	Fundamental Phasor
Pickup level	3 to 300 in steps of 1 V
Reset level	97% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

s) AUXILIARY OVERVOLTAGE (59X)

Voltage Input	Fundamental Phasor
Pickup level	3 to 300 in steps of 1 V
Reset level	97% of the pickup level

Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

t) AUXILIARY UNDERVOLTAGE (27X)

Voltage Input	Fundamental Phasor
Pickup level	3 to 300 V in steps of 1 V
Reset level	97% of the pickup level
Level accuracy	±1% reading ±0.1% Full Scale from 10 to 275 V
Curve Shapes	Fixed time or inverse curve
Reset type	Instantaneous
Curve Multiplier (Time Dial)	0.00 to 900.00 s. in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

u) UNDERFREQUENCY (81U)

Pickup level	20.00 to 65.00 Hz in steps of 0.01 Hz
Reset level	Pickup + 0.03 Hz
Level accuracy	±0.01 Hz of the reading
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Minimum voltage threshold	30 to 300V in steps of 1 V
Timing accuracy	±3.5% of operate time or 100 ms. (whichever is greater)
Snapshot Events	Selectable by setting

v) OVERFREQUENCY (81O)

Pickup level	20.00 to 65.00 Hz in steps of 0.01 Hz
Reset level	Pickup - 0.03 Hz
Level accuracy	±0.01 Hz of the reading
Trip delay	0.00 to 900.00 s. in steps of 0.01 s
Reset delay	0.00 to 900.00 s. in steps of 0.01 s
Minimum voltage threshold	30 to 300V in steps of 1 V
Timing accuracy	±3.5% of operate time or 100 ms. (whichever is greater)
Snapshot Events	Selectable by setting

w) FORWARD POWER (32FP)

Current, Voltage	Fundamental Phasor (primary values)
Number of stages	2
Pickup level (two stages)	0.00-10000.00 MW in steps of 0.01 MW
Reset level	97% of the pickup level
Level accuracy for primary magnitudes	±3% complete range.
Trip delay (two stages)	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Block Time after close	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting

x) SENSITIVE DIRECTIONAL POWER (32)

Current, Voltage	Fundamental Phasor (primary values)
Number of stages	2
Pickup level (two stages)	-10000.00 to 10000.00 MW (primary values) in steps of 0.01 MW
Characteristic Angle (two stages)	0.00 to 359.99 in steps of 0.01
Reset level	97% of the pickup level
Accuracy for primary magnitudes	±3% complete range
Trip delay (two stages)	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Block Time after close	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting

y) BROKEN CONDUCTOR (I2/I1)

Pickup level	20.0-100.0% (I2/I1 ratio) in steps of 0.1%
Reset level	97% of the pickup level
Trip delay	0.00 to 900.00 s in steps of 0.01 s
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Minimum Phase Current Threshold	0.05 A
Snapshot Events	Selectable by setting
Operation Threshold	0.000 to 1.000 A in steps of 0.001 A

Note: The I2/I1 current inhibition level for the different firmware versions is as follows

Firmware Version	Current Inhibition Level
1.50 or Lower	10 mA
1.60 or Higher	50 mA
1.80 or Higher	Selectable by setting from 0.000 to 1.000 in steps of 0.001 A

z) LOCKED ROTOR (48)

Current Input	Phasor (without harmonics) or RMS
Rated current	For connection to 1 or 5 A CTs.
Full Load Current	0.10 to 10.00 KA in steps of 0.01 KA
Pickup level	1.01 to 109.00 in steps of 0.01
Reset level	97% of the pickup level
Level accuracy for primary magnitudes	±3% complete range.
Trip delay	0.00 to 900.00 s. in steps of 0.01 s.
Reset delay	0.00 to 900.00 s. in steps of 0.01 s.
Operate time	20 ms at 3 x Pickup at 50 Hz, typically
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

2.4.2 CONTROL

a) AUTORECLOSE (79)

Schemes	Three-pole tripping schemes
Number of shots	Up to 4 reclose attempts before lockout
Dead time	Independent dead time setting before each shot adjustable between 0 and 900 s in steps of 0.01 s
Reclaim time	0.00 to 900.00 s in steps of 0.01 s
Condition permission	Selectable by setting
Hold time	0.00 to 900.00 s in steps of 0.01 s
Reset time	0.00 to 900.00 s in steps of 0.01 s
Snapshot Events	Selectable by setting

Possibility to modify protection settings after each shot programmable through PLC (block signals available after each shot)

b) SYNCHROCHECK (25)

Dead/live levels for line and bus	0.00 to 300.00 in steps of 0.01 V
Maximum voltage difference	2.00 to 300.00 V in steps of 0.01 V
Maximum angle difference	2.0º to 80.0º in steps of 0.1º
Maximum frequency slip	10 to 5000 mHz in steps of 10 mHz
Synchronism time	0.01 to 600.00 s in steps of 0.01 s
Angle accuracy	2º
Dead Source function	None (DL-DB) Dead Line - Dead Bus (LL-DB) Live Line-Dead Bus (DL-LB) Dead Line – Live Bus
Snapshot Events	Selectable by setting

c) FUSE FAILURE

Algorithm based on positive sequence of voltage and current
Activation by V_2/V_1 ratio

d) BREAKER FAILURE (50BF)

Current Input	Fundamental Phasor (without harmonics)
Rated current	For connection to 1 or 5 A CTs.
Pickup level for supervision	0.05 to 160.00 A in steps of 0.01 A
Pickup level for high level	0.05 to 160.00 A in steps of 0.01 A
Pickup level for low level	0.05 to 160.00 A in steps of 0.01 A
Pickup level for internal arcing	0.05 to 160.00 A in steps of 0.01 A
Reset level	97% of the pickup level
Level Accuracy	±0.5% of the reading ± 10 mA from 0.05 to 10 A ±1.5% of the reading for higher values.
Timing accuracy	±3.5% of operate time or 30 ms. (whichever is greater)
Snapshot Events	Selectable by setting

e) BREAKER SETTINGS

Number of Switchgear	1 to16 (selection of switchgear for breaker control)
Maximum KI^2t	0.00 to 9999.99 in steps of 0.01 $(kA)^2$ s
KI^2t integration Time	0.03 to 0.25 s in steps of 0.01 s
Maximum openings	0 to 9999 in steps of 1
Maximum Openings in one hour	1 to 60 in steps of 1
Snapshot Events	Selectable by setting

f) BREAKER MAINTENANCE

KI^2t Breaker Counters for Phases A, B, C	0.00 to 9999.99 in steps of 0.01 $(kA)^2$ s
Breaker Openings Counter	0 to 9999 in steps of 1
Breaker Closings Counter	0 to 9999 in steps of 1

g) SWITCHGEAR

Switchgear	1 to16 (configurable in “relay configuration” screen).
Snapshot Events	Selectable by setting (for each switchgear in “system setup”)

a) OSCILLOGRAPHY

Maximum Records:	Up to 20 Oscillography records.
Sampling rate:	Programmable to 4, 8, 16, 32 or 64 samples per power cycle
Capacity per record:	27592 samples No of Oscillos * No of samples/cycle
Trigger position:	5% to 95% of total length
Trigger:	Programmable via PLC
Data:	5 current channels and 4 voltage channels Up to 16 digital channels programmable through PLC
Data Storage:	In non volatile memory (flash) without battery
Format:	International Standard COMTRADE ASCII - IEEE C37.111-1999.
Automatic Overwrite:	Selectable by setting. (Oscillography records can be concatenated)
Snapshot Events:	Selectable by setting

b) FAULT LOCATOR

Method:	Single-ended
Positive Sequence Module:	0.01 to 250.00 Ohm in steps of 0.01 Ohms
Positive Sequence Angle:	25 to 90º in steps of 1º
Zero Sequence Module:	0.01 to 750.00 Ohms in steps of 0.01 Ohm
Zero Sequence Angle:	25 a 90º in steps of 1º
Line Length:	0.0 to 2000.0 in steps of 0.1 (miles or km)
Accuracy:	5% (typical)
Display Fault on HMI:	Selectable by setting
Snapshot Events:	Selectable by setting

Maximum Records:	Up to 10 fault report records.
Data:	Fault date and time, pre-fault currents and voltages, fault currents and voltages, fault type, distance to the fault (fault location), line parameters, recloser and breaker status information.
Data Storage:	In non volatile memory (flash) without battery available through communications In volatile memory (ram) available through HMI (if selectable by setting)
Format:	Text in ASCII format

c) SNAPSHOT EVENTS

Capacity:	479 scrolling events
Time-tag	1 ms using an internal clock of 100 μs
Timing Accuracy:	1 ms (using the IRIG-B synchronization input)
Triggers:	Any element pickup, dropout Digital input /output change of state By virtual inputs and control events
Data Storage	In non volatile memory (flash) without battery

The snapshot event recording procedure can be enabled or disabled by setting for each protection function

d) CONTROL EVENTS

Capacity:	128 events programmable through PLC
Time-tag:	1 ms using an internal clock of 100 μs
Timing Accuracy:	1 ms (using the IRIG-B synchronization input)
Triggers:	By any digital signal programmable through PLC
Alarm	Possibility to display the event as an alarm on the alarms panel. Information available always through Communications for all models and also in HMI for models with graphical display (M in ordering code).
Data Storage:	In non volatile memory (flash) without battery

Control events are also displayed in the snapshot events recording

e) DEMAND

Channels:	9
Parameters:	Ia (kA RMS), Ib (kA RMS), Ic (kA RMS), Ig (kA RMS), Isg (kA RMS), I2 (kA), P (MW), Q (MVAr) and S (MVA)
Current and Power Method	Thermal Exponential, Block Interval, Rolling Demand
Measurements:	Each channel shows the present and maximum measured value, with date and time for the maximum recorded value.
Samples:	5, 10, 15, 20, 30, 60 minutes.
Accuracy:	±1%
Trigger Input	Selectable by setting (operation mode selection for the Block Interval calculation method)
Snapshot Events:	Selectable by setting

f) DATA LOGGER

Number of Channels:	1 to 16
Parameters	Any available analog actual value
Samples	1 sec., 1, 5, 10, 15, 20, 30, 60 min.
Storage Capacity	Fixed, 32768 measures

2.4.4 USER –PROGRAMABLE ELEMENTS

a) PLC LOGIC

Programming language:	The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.
Lines of code:	512
Supported operations:	NOT, XOR, OR (2 to 8 inputs), AND (2 to 8 inputs), NOR (2 to 8 inputs), NAND (2 to 8 inputs), Latch (Reset Dominant), Edge Detectors, Timers. 2 inputs default gates, from 3 to 8 inputs provided in library format.
Libraries:	Logical gates fully programmable by user. To create user-programmable logic to be distributed as a single object.
Inputs:	Any logical variable, contact or virtual input
Number of timers:	8 maximum in each logic scheme (provided in library format)

b) FLEXCURVES

Number:	4 (A through D)
Reset points:	40 (0 through 1 of pickup)
Operate points:	80 (1 through 20 of pickup)
Time delay:	0 to 65535 ms in steps of 1
Saturation Level	20 times the pickup level

c) USER-PROGRAMMABLE LEDS

Number:	15 configurable LEDs plus a ready non configurable LED
Programmability:	from any logical variable, contact, or virtual input
Reset mode:	Self-reset or Latched. The first 5 LED's are latched by hardware (red color ones), usually configured for trip signals. The following 10 ones (yellow and green) are self-reset but can be latched through PLC configuration.
Reset Signal:	The LED's can be reset by hardware, pressing the front "esc" key during more than 3 seconds or using the LED reset signal through PLC configuration.

d) USER-DEFINABLE DISPLAYS

Number of configurable displays:	1 (one line diagram fully configurable). In graphical displays only
Number of fixed displays:	6, Metering (in primary values), Snapshot events (all and new), Alarms, Inputs and outputs screen with test functionality for inputs and outputs. In graphical displays only
Number of selectable displays:	Logotype, metering or both in scrolling mode, can be selectable as default screen in text display for all models (basic and mimic). The metering screen contains current and voltages for phases and ground in primary values.

e) USER-PROGRAMMABLE FRONT KEYS

Number of configurable Keys:	5
Operation:	drive PLC operands

2.4.5 METERING

a) CURRENT

Accuracy:	±0.5% of the reading ± 10 mA from 0.05 to 10 A (for phases and ground) ±1.5% of the reading ± 1 mA from 0.005 to 5 A (for sensitive ground) ±1.5% of the reading for higher values

b) VOLTAGE

Accuracy:	±1% reading ±0.1% Full Scale from 10 to 275 V

c) REAL POWER (WATTS)

Accuracy:	±1% of the reading at-0.8 < PF = -1 and 0.8 <PF=1

d) REACTIVE POWER (VARS)

Accuracy:	±1% of the reading at-0.2 = PF = 0.2

e) APPARENT POWER (VA)

Accuracy:	±1% of the reading

f) WATT-HOURS (POSITIVE AND NEGATIVE)

Accuracy:	±1% of the reading
Range:	±0 to 2147 MWh
Parameters:	3-phase only
Update rate:	100 ms

g) WAR-HOURS (POSITIVE AND NEGATIVE)

Accuracy:	±1% of the reading
Range:	±0 to 2147 MVArh
Parameters:	3-phase only
Update rate:	100 ms

h) POWER FACTOR

Accuracy:	0.02
Parameters:	3-Phase and single phase

i) FREQUENCY

Accuracy:	±10 mHz at 50 Hz ±12 mHz at 60 Hz

j) ANGLE

Accuracy:	2º

2.4.6 INPUTS

a) AC CURRENT INPUTS

CT Ratio:	1.0 to 6000.0 in steps of 0.1
Rated currents:	Appropriate for 1 or 5 A. F650 has universal range for CT (valid for 1 or 5 A to only one terminal).
Relay Burden:	< 0.04 Ohm
Current Withstand	Continuous at 20 A 1 second at 500 A for phases and ground 1 second at 50 A for sensitive ground

b) AC VOLTAGE INPUTS

VT Ratio	1.0 to 6000.0 in steps of 0.1
Rated Voltages	275 Vac
Metering range:	From 2 to 275 Vac
Relay Burden:	0.05 VA at 120 Vac (50 or 60 Hz)
Voltage Withstand:	Continuous at 260 V to neutral 1 min/hr at 420 to neutral

VAC inputs do not need varistors, as the impulse test is applied to 100% of the transformers

c) DIGITAL INPUTS

Input Activation Voltage Threshold:	1 to 255 Vdc in steps of 1 V (selectable by setting)
Impedance:	> 100 kOhm
Maximum error:	±10% setting ± 2.5 V
Load for voltage supervision inputs:	2 mA + V/100 kOhm
Voltage threshold for voltage supervision inputs	< 10 V (fixed)
Debounce Time:	1 to 50 in steps of 1 ms
Recognition time:	< 1ms
Timing resolution:	1 ms

For Input Activation Voltage Threshold and Debounce Time there is a single setting for all inputs in the same group (inputs sharing the same common). In mixed and supervision boards there are two groups of inputs, called A and B.

Input Type and Delay Input Time are not grouped; there is a different setting for each input.

Input Type	Positive-Edge / Negative-Edge / Positive/ Negative
Delay Input Time	0 to 60000 ms in steps of 1 ms (Input signal time delay)

d) IRIG-B INPUT

Amplitude modulation:	DC SHIFT = Demodulated input (no carrier)
Input Voltage:	TTL
Input Burden:	1.5 mA
Input Impedance:	3.3 kOhm
Minimum Input Voltage:	2.4 V
Maximum Input Voltage:	+/- 24 V
Formats:	B000 (*) B001, B002 and B003 (*) (*) Signal combinations recognized in accordance with IRIG Standard 200-95
Isolation:	2 kV

2.4.7 REAL TIME CLOCK

Accuracy:	Typical ±20 ppm
Backup energy:	More than 1 week

2.4.8 OUTPUTS

Carry continuous:	16 A
Make and Carry for 1 sec	60 A
Break at L/R of 40 ms:	0.3 A DC max. at 125 Vdc 0.25 A DC max. at 250 Vdc
Operate Time:	< 8 ms
Contact material:	Silver Alloy

Output Logic Type, Output Type and Pulse Output Time are selectable by setting for each output

Output Logic Type	Positive / Negative
Output Type	Normal / Pulse / Latch (Selectable by setting for each output)
Pulse Output Time	0 to 60000 ms in steps of 1 ms (applicable only to signals set as pulse type)

Separate operate and reset signal can be configured by any digital signal programmable through PLC

Contact Outputs (F31-F33, F34-F36) for board type 2 (supervision) in slot F:	The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 100 mA, the function is sealed independently of the status of the function that caused the trip.

2.4.9 CONTROL POWER SUPPLY

LOW RANGE (LO)	
Nominal DC Voltage:	24 to 48 V
Min/Max DC Voltage	19.2 / 57.6 V
Note:	Low range is DC only
HIGH RANGE (HI)	
Nominal DC Voltage:	110 to 250 V
Min/Max DC Voltage	88 / 300 V
Nominal AC Voltage:	120 to 230 V
Min/Max AC Voltage	102 / 250 V
ALL RANGES	
Voltage Loss hold-up time	200 ms typical, worst case 100 ms without unit reset
Power consumption	Typical =25 VA, Maximum =45 VA

Display backlight auto power-off mode after 15 minutes without touching any key, in order to ensure long life and minimum consumption.

2.4.10 COMMUNICATIONS

FRONT PORT:	
Front port:	COM2
Type	RS232
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 y 115200 bauds
Default Baud Rate	19200
Protocols available:	ModBus® RTU / DNP 3.0
Typical distance:	1200 m
Isolation:	2 kV
ASYNCHRONOUS REAR PORTS:	
None or two rear ports (depending on model):	COM1, COM2 (rear COM2 multiplexed with front port)
Type (depending on model):	
Model F	None
Model A	Two RS485 ports
Model X	Two RS485 ports with CAN for inputs/outputs module
Model P	Two 1mm-plastic F.O. ports
Model Y	Two 1mm-plastic F.O. ports with CAN for inputs/outputs module
Model G	Two multimode glass F.O. ports with ST connectors
Model Z	Two multimode glass F.O. ports with ST connectors with CAN for inputs/outputs module
Optic Features for ST connectors devices:	Wave length: 1300nm Fiber type: multimode 62.5/125 μm or 50/125 μm
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 y 115200 bauds
Default Baud Rate	19200

Protocols available:	ModBus® RTU / DNP 3.0
Typical distance:	1200 m
Isolation:	2 kV
CAN PORT:	
Rear port:	CAN port in models X, Y, Z for asynchronous rear ports
Type:	Multimode glass F.O. port with ST connectors
Wave length:	1300 nm
Fiber type:	multimode 62.5/125 μm or 50/125 μm
Isolation:	2 kV
ETHERNET PORT:	
Rear port:	COM3
Type (depending on model):	
Model B:	10/100BaseTX self-negotiable
Model C:	10/100BaseTX + 100Base FX
Model D:	10/100BaseTX + Double 100BaseFX (Physical media redundancy)
10/100BaseTX	RJ45 connector
100BaseFX	ST connectors
Wave length:	1300 nm
Fiber type:	multimode 62.5/125 μm or 50/125 μm
Protocols available:	ModBus® TCP/IP
	DNP over TCP/IP and UDP/IP
	IEC 870-5-104
	Http, ftp, tftp (allow the use of a standard Internet browser)
Typical distance:	1.65 km
Response time to ModBus commands:	10 ms Typical
Isolation:	2 kV

In Models C and D, the 10/100BaseTX port is selected by an internal switch (see 3.3.3)

Two witness LED's for transmission and reception are included

2.4.11 ENVIRONMENTAL CHARACTERISTICS

Operating temperature:	- 10°C to + 60°C
Storage temperature:	- 40°C to + 80°C
Humidity (non condensing):	95%
Altitude	Up to 2000 m
Installation category	II

2.4.12 PACKAGING AND WEIGHT

Net weight:	5 kg
Packaged:	6 kg
Package dimensions:	30x40x40 cm (DxWxH)

2.4.13 TYPE TESTS

Category	Standard	Class	Test
EMC	IEC 61000-4-1 IEC 60255-22-1	III	Oscillatory waves immunity
	IEC 61000-4-2 IEC 60255-22-2	IV	Electrostatic discharge immunity test
	IEC 61000-4-3 IEC 60255-22-3	III	Radiated electromagnetic field disturbance test
	IEC 61000-4-4 IEC 60255-22-4	IV	Electrical fast transient
	IEC 61000-4-5 IEC 60255-22-5	IV	Surge immunity test
	IEC 61000-4-6 IEC 60255-22-6	III	Conducted electromagnetic field disturbance test
	IEC 61000-4-8 EN 61000-4-8	IV	Power frequency magnetic field immunity
	ENV50204	III	Radiated electromagnetic field disturbance test – 1890 MHz.
EMC Emisivity	IEC 60255-25 EN 61000-6-4	A	Conducted and radiated emissions
Product	IEC 60255-5	2 kV	Insulation resistance – dielectric test
	IEC 60255-5	6kV .5J	Impulse test
	IEC 60255-11	100 ms	Power supply Voltage dips/interruptions/variations:
Mechanical	IEC 60255-21-1	I	Vibration test (sinusoidal)
	IEC 60255-21-2	I	Shock and bump
	IEC 60255-21-3	II	Seismic

Type test report available upon request.

F650 has been designed to comply with the highest existing requirements. More specifically, UNIPEDE recommendations for high voltage substations are followed, even if for most applications such high classes are not required.

The relay complies with ANSI C37.90 standards, and has been designed to comply with international standards.

2.4.14 APPROVALS

ISO9001 Registered system.

CE marking: Meets the CE standards relevant for protections.

2

F650 units can hold two different options for F module:

Option 1:Board with 16 inputs and 8 outputs.

Option 2: Board with 8 digital inputs, 4 circuit supervision outputs, 6 conventional outputs, and two current sensing outputs

Each model has a different wiring diagram, as follows:

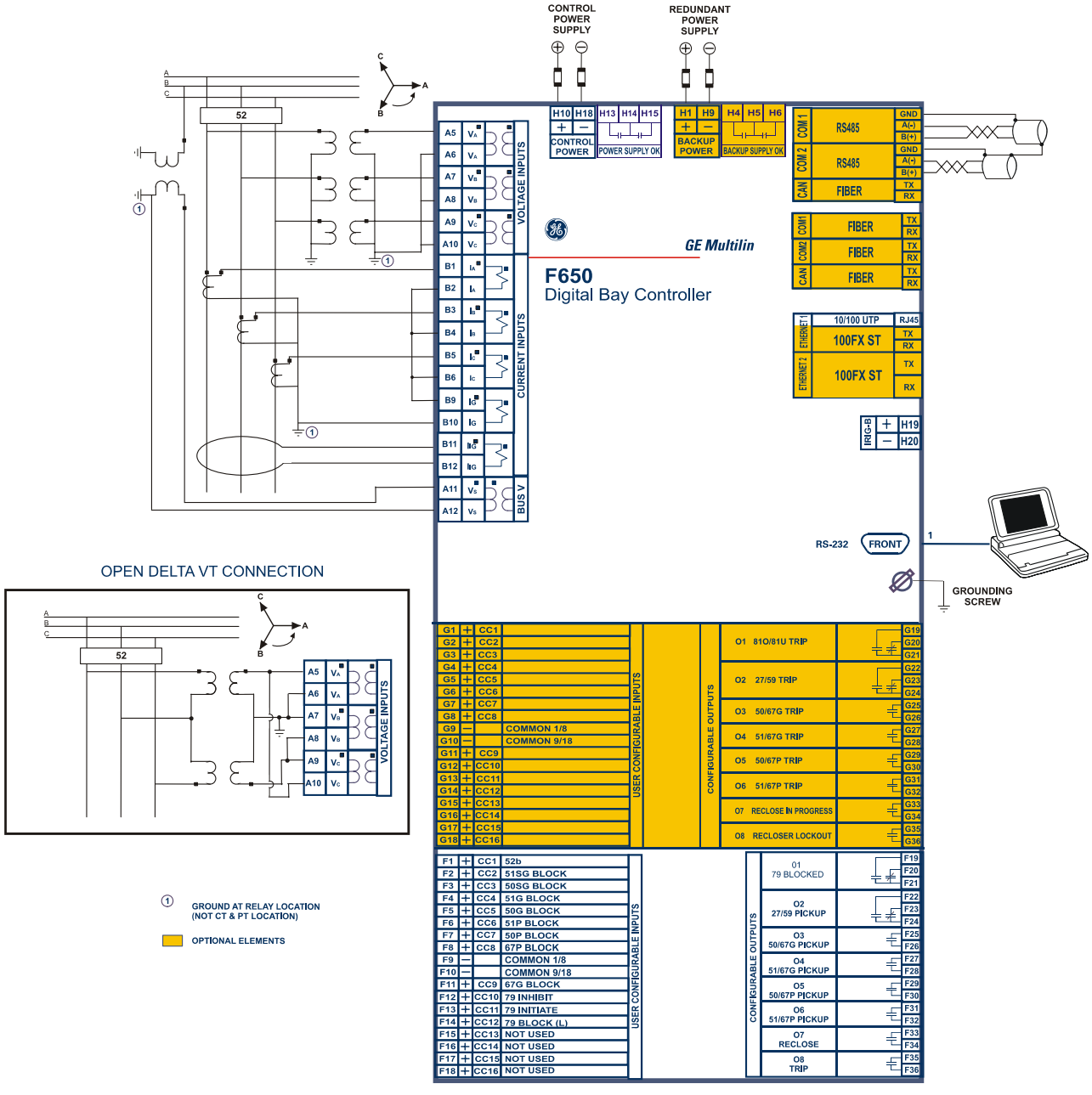


Figure 2–2: WIRING DIAGRAM FOR MODELS WITH OPTION 1 (189C4216H3)

The option 2 wiring diagram is shown below:

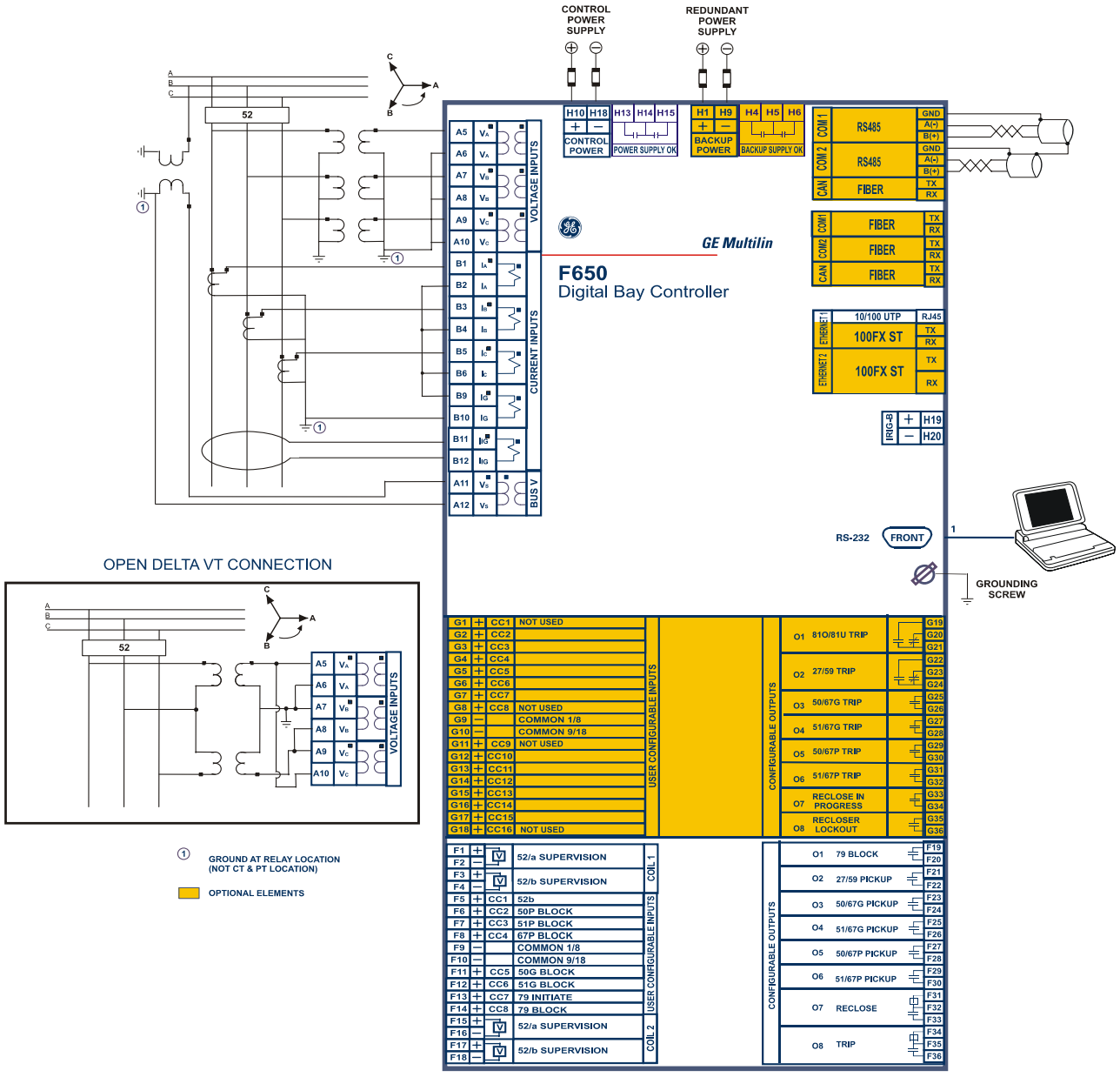


Figure 2–3: WIRING DIAGRAM FOR MODELS WITH OPTION 2 (189C4216H2)

3.1.1 OVERVIEW

This software package uses ModBus protocol, and it is designed to communicate with a single relay at a time. GE offers different communication software packages, such as GE-POWER, which can be used to communicate simultaneously with several relays.

EnerVista 650 Setup software provides an easy way to configure, monitor and manage all F650 features.

a)Setting files

EnerVista 650 Setup software provides two ways of working with setting files:

1.OFF LINE Mode: Creating or editing setting files not connected to the relay, to be stored later in the proper unit.

2. ON LINE Mode: Connecting to the relay. This on line mode allows settings modifications, reading metering values, internal status, oscillography records, event records, etc.

b) Configuration

The relay allows to fully program all the inputs, outputs, LEDs, control events, operations, block signals in protection elements, switchgear, one line diagram in HMI, and create internal logic.

For simple relay configurations a direct configuration can be used (Relay configuration screen), and for more complex configurations a PLC Editor tool is provided (Logic Configuration screen).

c) Monitoring of all metering values, internal states, inputs and outputs provided by F650 device.

d) Performing the previously configured operations

e) Updating of operating system, firmware version and web server utility.

f) One line diagrams configuration (bay mimics) for its use in models with graphical display only.

g) Registering data info for control events, snapshot events, alarms, fault reports, oscillography files, data logger, etc.

EnerVista 650 Setup software provides the following areas:

- Title
- Main menu bar
- Main icon bar
- Working area
- Status bar

Figure 3–1: ENERVISTA 650 SETUP MAIN SCREEN

To start communicating with the relay go to "***Communication>Computer>Computer settings***" section in the main EnerVista 650 Setup menu.

Safety instructions must be followed before connecting the computer to the relay. Safety instructions are detailed in section 1.1.3 SAFETY INSTRUCTIONS. Connect the relay ground terminal and the communicating computer to a good grounding. Otherwise, communication may not be viable, or even, in worst cases, the relay and/or the computer could result damaged by overvoltages.

For on-line working, previously ensure that all relay communication parameters, such as baudrate, slave ModBus address, etc, match the computer settings.

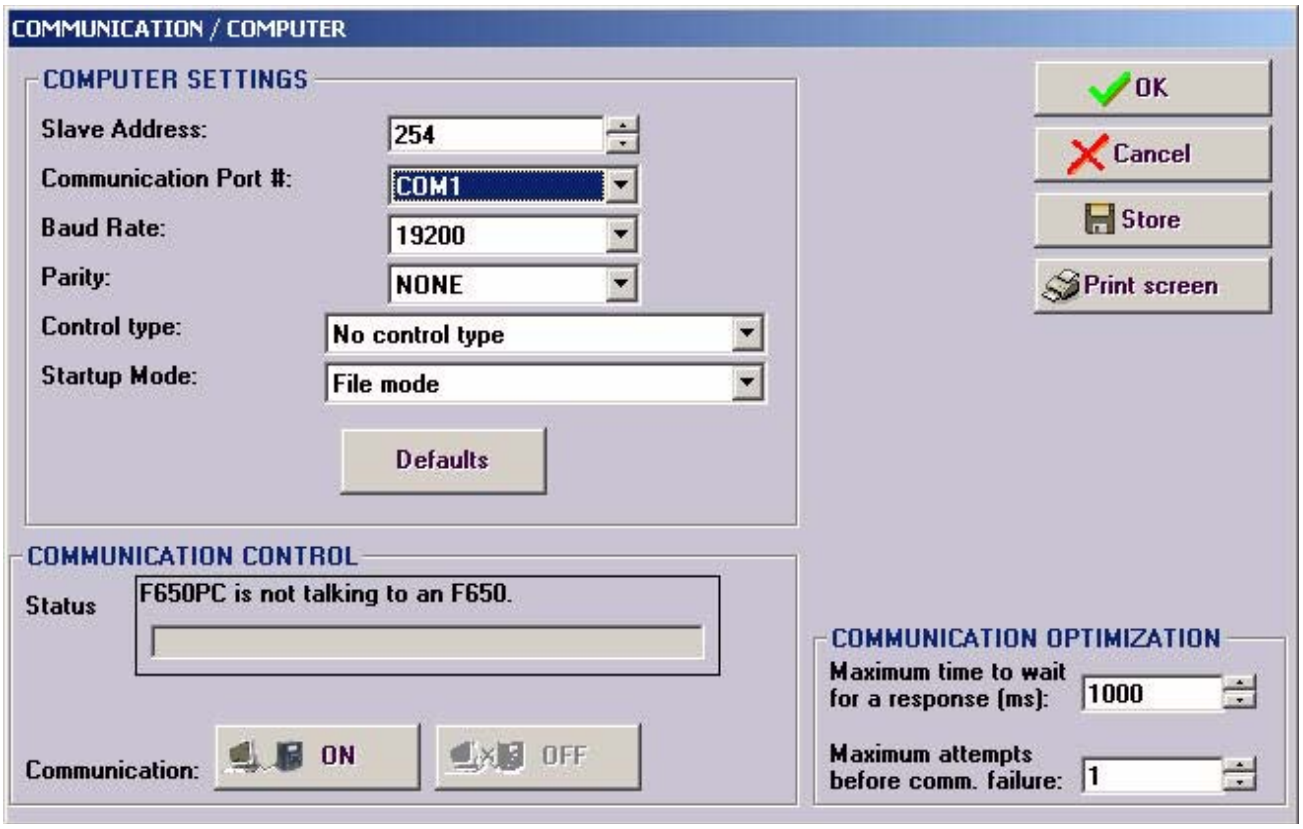


Figure 3–2: COMMUNICATION PARAMETERS MENU

The ***"Communication > computer"*** screen is divided in several subsections:

Computer settings: Main communication parameters for serial communication and control type selection.

ModBus/TCP Setup (if ModBus /TCP is selected as control type): Communication parameters for ModBus TCP communication.

Communication control: Device communication status (communicating or not communicating).

Communication optimization: allows optimizing the communication time outs and failure establishing.

COMPUTER SETTINGS:

Shows the communication parameters necessary in order to establish communication with the unit. Such as slave address, communication port, baud rate, parity, control type and startup mode.

Baud rate, parity, data bits, stop bits and ModBus slave address for com2 (RS232 front port and second serial port in the rear communication board) are displayed in the default text logotype main screen.

ModBus Slave Address: ModBus addresses used for serial and Ethernet communication. These parameters can be accessed through the relay HMI and EnerVista 650 Setup software. In Relay HMI: go to ***"Main screen>View or Change Settings menu >Product Setup>Communication> ModBus Protocol"***.

To move through the HMI, press intro (press in shuttle key) to enter in the internal menus and "esc" to exit.

In EnerVista 650 Setup go to ***"Setpoint>Product Setup>Communication Settings>ModBus Protocol"***

Communication ports: port used in the computer for serial communication.

Baud Rate: Baud rate for serial communication (from 1200 up to 115200 bauds in EnerVista 650 Setup, from 300 to 115200 in relay).

Parity: parity for serial communication. None, odd or even can be selected.

Baud rate and parity are serial communication parameters located both in serial ports menu. In relay HMI: go to ***"Main screen>View or Change Settings menu >Product Setup>Communication> Serial Ports"***. In EnerVista 650 Setup, go to ***"Setpoint>Product Setup>Communication Settings>Serial Ports"***.

Control Type: The available control modes are:

- No Control Type, this option selects the serial communication mode, for use with serial communication ports (front port, RS485, or plastic or glass fiber optic).
- MODBUS/TCP, this option selects ModBus TCP/IP communication mode, for communication through the Ethernet port. In this case, the top right window will show the typical parameters to be programmed; IP address, port address and unit identifier in the MODBUS TCP SETUP section.

  To access the relay IP address in relay HMI, go to ***"Main screen>View or Change Settings menu >Product Setup>Communication> Ethernet>Ethernet 1 or 2"***. In EnerVista 650 Setup, go to "Setpoint>Product Setup>Communication Settings>Network (Ethernet)>Ethernet 1 or 2".

  For port address and unit identifier, in relay HMI go to "***Main screen>View or Change Settings menu >Product Setup>Communication>ModBus Protocol"***. In EnerVista 650 Setup, go to "***Setpoint>Product Setup>Communication Settings>ModBus Protocol"***.
- MODEM, this option displays the parameter to set in case of using a modem for the communication, such as Phone number, Time out (sec), init. command, type of dialing (tones or pulses).

COMMUNICATION CONTROL:

The Communication Control subsection is located on the bottom left communication window and shows the communication status in the relay. There are two legends, "Status" in which the communication text status will be displayed and "Communication" which includes two buttons to start (ON) and stop (OFF) the communication with the relay.

Relay NOT communicating: In status, a message will be displayed with the communication status, e.g. 650 Setup is not talking to an F650. The ON button will be available to press and the OFF button will be disabled (in grey color). In this stage the relay is not communicating to the computer and the communication parameters can be modified to establish the communication lately by pressing in the ON communication button.

Relay communicating: In status, a message will be displayed with the communication status, e.g. 650 Setup is now talking to an F650. The ON button will be disabled (in grey color) and the OFF button will be available to press. In this stage the relay communicating to the computer and the communication parameters cannot be modified. In the example on Figure 3–2: COMMUNICATION PARAMETERS MENU , communication has not been established yet.

COMMUNICATION OPTIMIZATION:

The parameters shown on the bottom right window (Communication optimization) can improve communication, although it is recommended to leave the default values indicated by the EnerVista 650 Setup. These parameters are the maximum time to wait for a response in the relay (in ms) and the maximum attempts to perform before assuming communications failure.

The rest of options available in the Communication menu in EnerVista 650 Setup are:

- Modem: Allows configuring the unit for remote communications via modem, using telephonic line. It is only available if the relay is not communicating and if modem has been select on Communication>computer control type selection. Go to ***"Communication>Modem"***
- Troubleshooting (Serial or Ethernet connection): Lets the user to perform reading or writing in ModBus addresses, for verifying communications and access to different positions in the ModBus memory map. Only available if the communication has already been established. Go to ***"Communication>Troubleshooting"***. An example is provided in Figure 3–3:

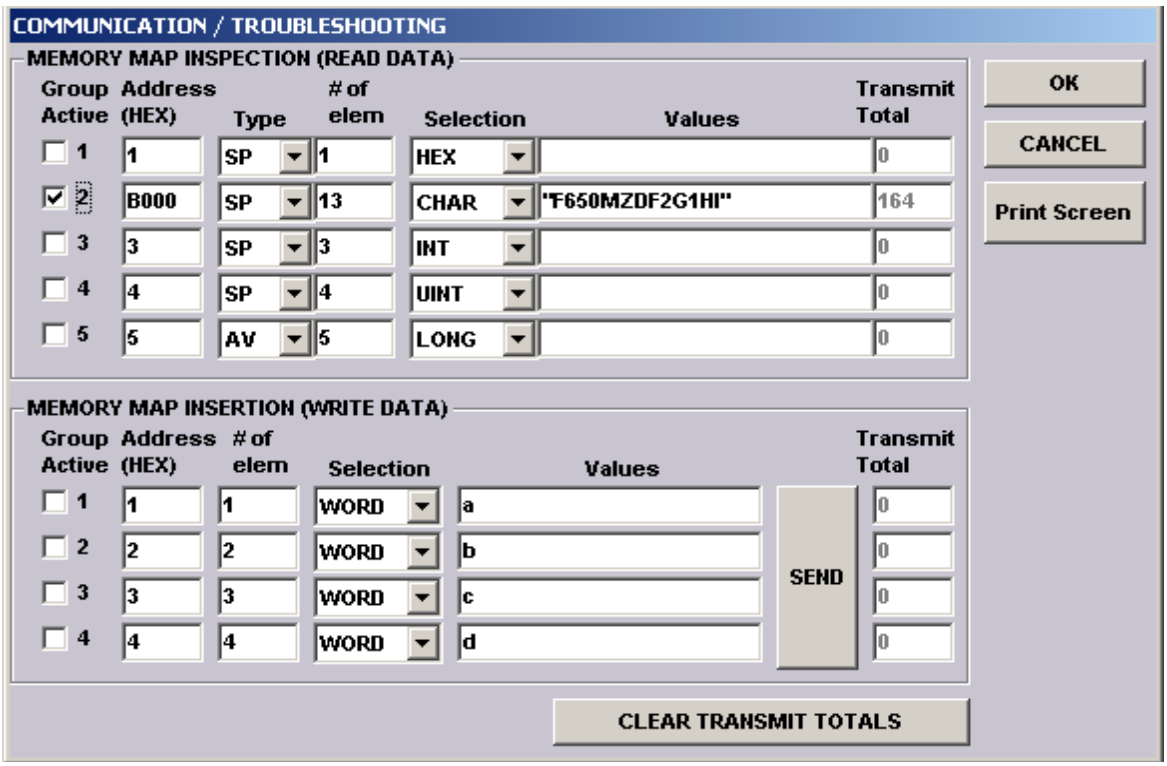


Figure 3–3: COMMUNICATION TROUBLESHOOTING SCREEN

- Calibration (Serial or Ethernet connection): Allows retrieving the unit calibration settings and storing them in a file (with extension *.cal). For reading or storing the calibration settings in the relay go to ***"Communications>Calibration>Get or Set calibration settings"*** and select the intended calibration file. The calibration retrieval process is necessary to be performed before updating the unit boot code, when the operating system is updated all the data in the relay is deleted, including the factory calibration settings. When only the firmware is updated (for versions higher than 1.50), the calibration settings are automatically saved in the relay.
- Upgrade firmware version (Ethernet connection): Go to ***"Communications>Upgrade firmware version"***, this menu allows the user to update the firmware version of the relay through Ethernet communication. Firmware is related to the relay internal program, designed by GE Multilin, which performs the protection and control functions, and which is run by the relay main microprocessor.
- Upgrade operating system (Serial and Ethernet connection): Go to ***"Communications>Upgrade operating system"***. This option allows the user to update the relay boot code. This is the program that supports the firmware and provides auxiliary services for access to electronic devices included in the relay.

IMPORTANT NOTE:

READ CAREFULLY THE FLASH MEMORY UPDATE PROCEDURE AND CLOSE ALL THE RUNNING APPLICATIONS BEFORE PERFORMING FIRMWARE AND boot code UPDATING PROCCESS
Before updating firmware check that the firmware version that is going to be updated match the boot code version of the relay. Otherwise it is necessary to update the boot code before proceeding to update the firmware. Other combinations of firmware and boot code different from the listed below will not be operative
The boot code version is available in the logotype main screen in HMI; it is the number between brackets in the first line, e.g. F6501.70 (2.35). The boot code version is 2.35
Firmware version up to 1.5X must be used with Boot Code 2.30 (or 2.20 and 2.35)
Firmware version from 1.6X up to 1.7X must be used with Boot Code 2.35

Thanks to the use of a double flash memory, one with the Bootcode startup program and the boot code, and a second one with the application program (firmware), a high reliability is guaranteed when updating the unit firmware, as even in the case of a communication breakdown during the firmware upgrade process, we can retry the process for an unlimited number of times.

- Upgrade 650 web server (Ethernet connection): Go to ***"Communications> Upgrade 650 web server"***. The relay web server application can be updated to further versions (if available) using this menu without modifying the relay boot code.
- Upload info files to relay (Ethernet connection): Go to ***"Communications>Upload info files to relay"***. This functionality is used to store setting files (*.650) inside the relay, as well as auxiliary files used by the programmable logic graphical editor (*.pep, *.aut, *.lib).
- Download info files from relay (Ethernet connection): Go to ***"Communications>Download info files from relay"***. This functionality is used for retrieving the files (*.650 and *.pep, *.aut, *.lib) that have been previously stored in the relay flash memory.

IMPORTANT NOTE:

*.650 files contain protection, control settings, relay configuration and compiled logic equations. This file can be retrieved from the relay, using the ***"File>Get info from relay"*** option in EnerVista 650 Setup (through serial or Ethernet communication). ***"File>Send info to relay"*** option stores this *.650 file in the relay.
*.pep, *.aut and lib files contain the logic configuration projects necessary to modify the logic (virtual outputs) in the relay. These files can be stored in the relay, using the ***"Communication>Upload info files to relay"*** option in EnerVista 650 Setup (through Ethernet communication). They can be retrieved using ***"Communication>Download info files to relay"*** option in EnerVista 650 Setup program (Ethernet communication). Take into account that the *.pep, *.aut and library files are necessary to modify the PLC logic (virtual outputs). Without these files setting and configuration can be modified but not logic equations (virtual outputs). It is advisable to use the ***"Communication>Upload info files to relay"*** option to store these logic configuration files into the relay.
It is important to distinguish between "***Send / Get info to relay***" and ***"Upload / Download info files to/from relay"***. ***"File>Send/Get info to relay"*** **sends/gets** settings and configuration and compiled logic equation to/from the relay (*.650 format), and the relay automatically starts working with the new settings once they are stored. "***Communications>Upload/Download info files to relay"***, **stores/retrieves** in the relay flash memory: settings, configuration and compiled logic equations (*.650) besides the PLC files (*.pep, *.aut, *.lib). This is only a physical storage (file backup).

File management with EnerVista 650 Setup software:

3.1.4.1 OFF LINE MODE WITHOUT CONNECTION TO THE RELAY

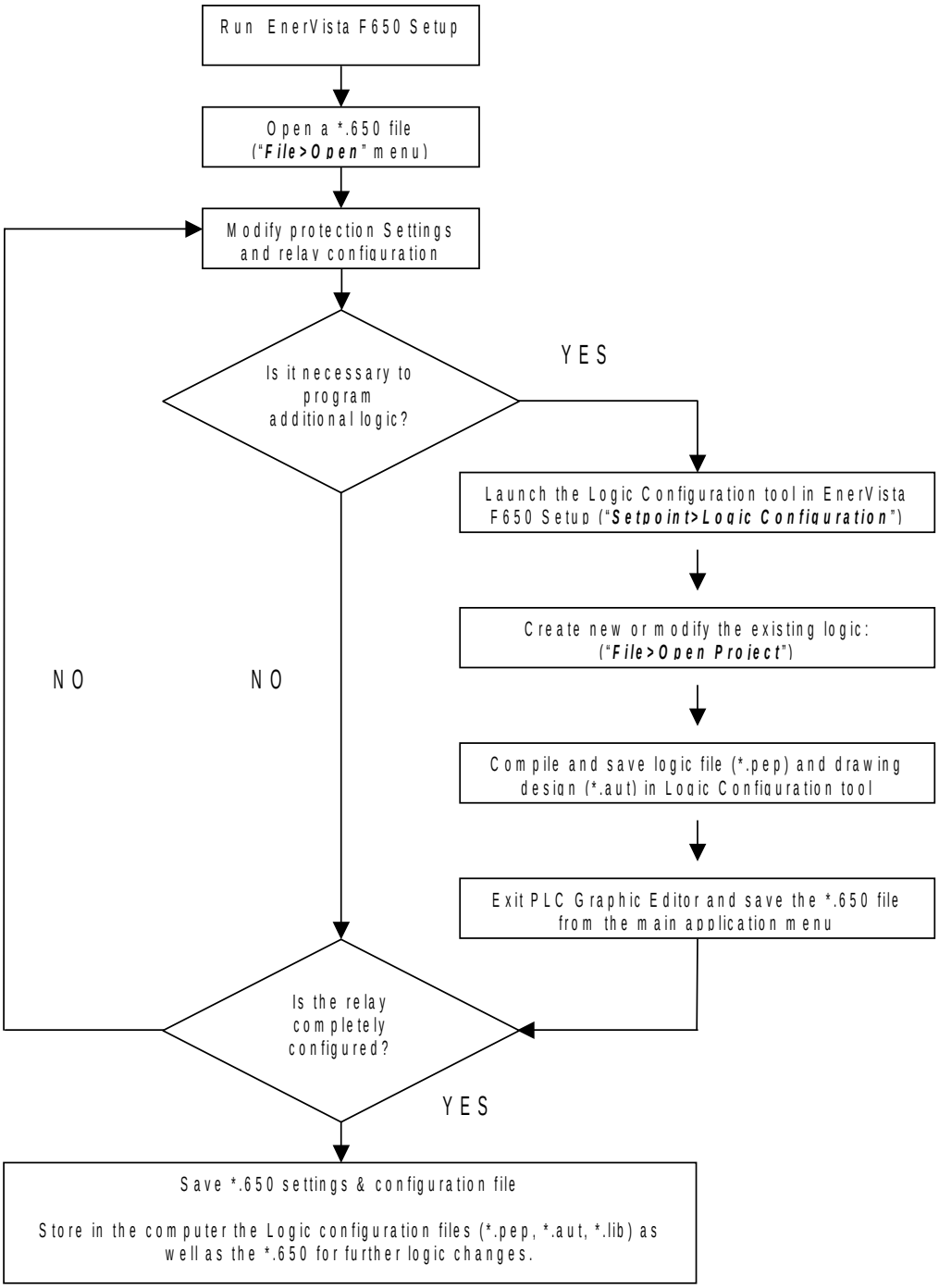

Run EnerVista F650 Setup
Open a *.650 file ("File>Open" menu)
Modify protection Settings and relay configuration
Is it necessary to program additional logic?
YES
NO
Launch the Logic Configuration tool in EnerVista F650 Setup ("Setpoint>Logic Configuration")
Create new or modify the existing logic: ("File>Open Project")
Compile and save logic file (*.pep) and drawing design (*.aut) in Logic Configuration tool
Exit PLC Graphic Editor and save the *.650 file from the main application menu
NO
Is the relay completely configured?
YES
Save *.650 settings & configuration file
Store in the computer the Logic configuration files (*.pep, *.aut, *.lib) as well as the *.650 for further logic changes.

Figure 3–4: OFF-LINE MODE FILE MANAGEMENT

NOTE 1: *Depending on the type of Inputs/Outputs incorporated in relay slots F and G, configuration options will be different. There are 2 template files available for working off-line with any F650 available model:*

F650_F1G0_V200.650: Board 1 in slot F and without any board in slot G.

F650_F1G1_V200.650: Board 1 in slot F and board 1 in slot G.

F650_F1G4_V200.650: Board 1 in slot F and board 4 in slot G.

F650_F1G5_V200.650: Board 1 in slot F and board 5 in slot G.

F650_F2G0_V200.650: Board 2 in slot F and without any board in slot G.

F650_F2G1_V200.650: Board 2 in slot F and board 1 in slot G.

F650_F2G4_V200.650: Board 2 in slot F and board 4 in slot G.

F650_F2G5_V200.650: Board 2 in slot F and board 5 in slot G.

Table 3–1: TYPES OF FILES GENERATED BY ENERVISTA 650 SETUP SOFTWARE OPERATION MODE OFF-LINE:

FILE TYPE	SETTINGS & CONFIGURATION FILE *.650		LOGIC CONFIGURATION FILES (*.PEP, *AUT, *.LIB)		
			*.PEP	*.AUT	*.LIB
Relevant sections inside the file	Protection Settings and Configuration Section	Compiled logic equations section	Header for Logic project	Graphical edition container. Logic equations in FDB format.	User programmable logic objects
Created by	EnerVista 650 Setup	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)
Definition and contents	Relay configuration file containing all protection elements Settings, input/output and LEDs configuration, graphic display configuration, etc.	Equations corresponding to the logic created and compiled in the PLC Editor	PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.	PLC Project file containing all the drawings used by the logic, required by F650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).	Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.
File storage in the PC	EnerVista 650 Setup: **"*File>Save **"**	EnerVista 650 Setup: **"*File>Save **"** It is necessary to store the logic configuration files used to create the PLC project for further logic modifications.	PLC Editor: **"*File>Save Project"**	PLC Editor: **"*File>Save Project"**	PLC Editor: **"*File>Save Library"**
File Retrieval of previously stored files in PC	EnerVista 650 Setup: **"*File>Open **"**	EnerVista 650 Setup: **"*File>Open **"** It is necessary to have the logic configuration files used to create the PLC project	PLC Editor: "***File>Open Project"**	PLC Editor: "***File>Open Project"**	PLC Editor: "***File>Library>New Library"**
Basic information transfer mode to the relay	Connect with the relay ("***Communications>Computer"**) Open the created file (**"*File>Open **"**) Send to relay from the menu: **"*File>Send info to relay"** Note that texts used in the configuration of inputs, outputs, etc. are not sent to the relay. The only texts sent to relay are operations, events, and LEDs.		Connect with the relay ("***Communications>Computer"**) Launch F650 PLC Editor ("***Setpoint>Logic Configuration"**) Open the created PLC project ("***File>Open Project"**) Compile the project ("***Run>Compile"**) Now the logic (virtual outputs) can be sent directly to relay ("***Run>Send Equations to Relay"**). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.		

In case of using element libraries (either existing ("***File Library>Open Library***") or created by the user ("***File Library>New Library***")), the program will create and manage the corresponding files (*.lib) in a folder named FDB (Functional Block Diagram). These files are used for the PLC project compilation. It is necessary to store them with the other logic configuration files that built the PLC project (*.pep, *.aut, *.lib).

Besides sending basic information to the relay (Settings + configuration) in *.650 format, it is recommended to store *.650, *.pep, *.aut and *.lib files inside the relay ("***Communication>Upload info files to relay***"), to ensure that logic configuration files will be available in the future for further logic modifications; either if these files are not used by the relay, they are required for connecting to a relay and analyzing its configuration. The program manages the logic configuration files globally, so that when the user selects to save file *.pep in the relay, the associated *.aut and *.lib files are also stored.

File storage inside the relay (RECOMMENDED)	"***Communication > Upload info files to relay***" through Ethernet
Retrieval of files stored in the relay (RECOMMENDED)	"***Communication > Download info files from relay***" through Ethernet

3.1.4.2 ON LINE MODE CONNECTED TO THE RELAY

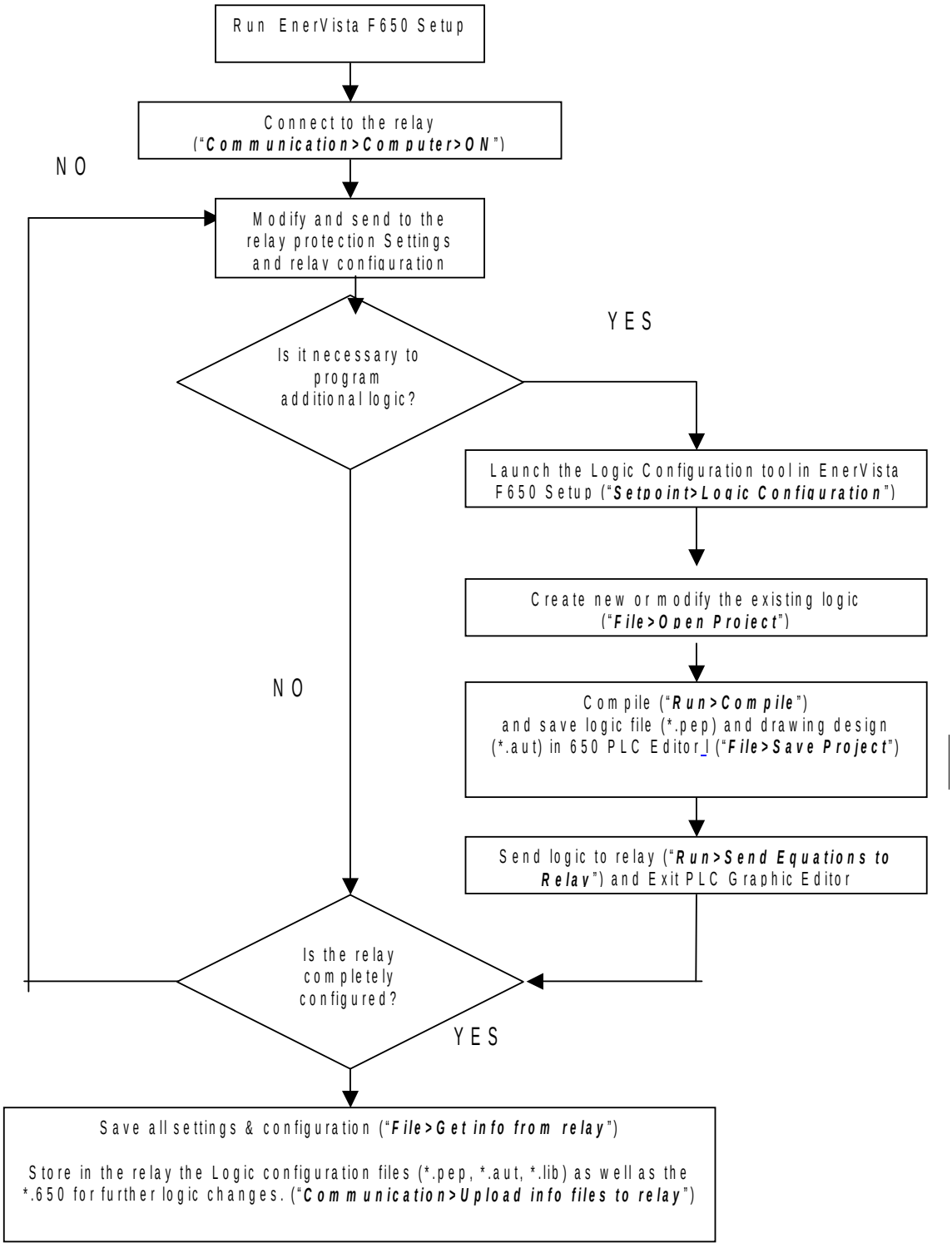

Run EnerVista F650 Setup
Connect to the relay ("Communication>Computer>ON")
NO
Modify and send to the relay protection Settings and relay configuration
Is it necessary to program additional logic?
YES
Launch the Logic Configuration tool in EnerVista F650 Setup ("Setpoint>Logic Configuration")
Create new or modify the existing logic ("File>Open Project")
NO
Compile ("Run>Compile") and save logic file (*.pep) and drawing design (*.aut) in 650 PLC Editor ("File>Save Project")
Send logic to relay ("Run>Send Equations to Relay") and Exit PLC Graphic Editor
Is the relay completely configured?
YES
Save all settings & configuration ("File>Get info from relay")
Store in the relay the Logic configuration files (*.pep, *.aut, *.lib) as well as the *.650 for further logic changes. ("Communication>Upload info files to relay")

Figure 3–5: ON LINE MODE FILE MANAGEMENT

Table 3–2: TYPES OF FILES CREATED BY ENERVISTA 650 SETUP– ONLINE OPERATION MODE

<table>
<tr><th>FILE TYPE</th><th colspan="2">SETTINGS & CONFIGURATION FILE *.650</th><th colspan="3">LOGIC CONFIGURATION FILES (*.PEP, *.AUT, *.LIB)</th></tr>
<tr><th></th><th colspan="2"></th><th>*.PEP</th><th>*.AUT</th><th>*.LIB</th></tr>
<tr><td>Relevant sections inside the file</td><td>Protection Settings and Configuration Section</td><td>Compiled logic equations section (relay configuration and logic configuration)</td><td>Header for Logic project</td><td>Graphical edition container. Logic equations (Virtual Outputs) in FDB format.</td><td>User programmable logic objects</td></tr>
<tr><td>Created by</td><td>EnerVista 650 Setup</td><td>Logic configuration graphic editor (PLC Editor) and relay configuration screen</td><td>Logic configuration graphic editor (PLC Editor)</td><td>Logic configuration graphic editor (PLC Editor)</td><td>Logic configuration graphic editor (PLC Editor)</td></tr>
<tr><td>Definition and contents</td><td>Relay configuration file containing all protection elements, settings, input/output and LEDs configuration, graphic display configuration, etc.</td><td>Equations corresponding to the logic created and compiled in the PLC Editor</td><td>PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.</td><td>PLC Project file containing all the drawings used by the logic, required by F650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).</td><td>Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.</td></tr>
<tr><td rowspan="6">Basic information transfer mode to the relay</td><td colspan="2">Connect with the relay (“Communications>Computer”)</td><td colspan="3">Connect with the relay (“Communications>Computer”)</td></tr>
<tr><td colspan="2">Send settings and configuration from file:</td><td colspan="3">Launch 650 PLC Editor (“Setpoint>Logic Configuration”)</td></tr>
<tr><td rowspan="2">Send protection and control settings to relay: “File>Send info to relay”, select *.650 file, choose Protection and Control settings option in screen and press send</td><td rowspan="2">Send configuration and logic compiled equation to relay: “File>Send info to relay”, select *.650 file, choose “Relay and Logic Configuration” option in screen and press send. When the message “Configuration stored” appear in the relay HMI the configuration has been stored.</td><td colspan="3">Open the created PLC project (“File>Open Project”)</td></tr>
<tr><td colspan="3">Compile the project (“Run>Compile”)</td></tr>
<tr><td colspan="2">Modify settings and configuration directly in the relay:</td><td colspan="3" rowspan="2">Now the logic (virtual outputs) can be sent directly to relay (“Run>Send Equations to Relay”). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.</td></tr>
<tr><td>Go to “Setpoint> >Product Setup >System Setup >Protection Elements >Control Elements >Inputs/Outputs” in EnerVista 650 Setup and modify the selected settings and press store to send them to the relay.</td><td>Go to “Settings>Relay Configuration> >Outputs >LEDs >Operations >Protection Elements >Oscillography >Operations >Control Events >Switchgear >Inputs >Virtual Inputs >Operations >MMI (HMI)” in EnerVista 650 Setup, modify the selected values and press store to send them to the relay.</td></tr>
<tr><td rowspan="4">File storage in PC</td><td rowspan="4">EnerVista 650 Setup: “File>Get info from relay”. User definable texts retrieved are operations, events, and LEDs.</td><td rowspan="4">EnerVista 650 Setup: The relay provides this information in a basic format (compiled equations). It is necessary to have the logic configuration files used for creating the PLC project to view the logic in a graphical way (FDB) and be able to modify it (virtual outputs).</td><td colspan="3">PLC Editor:</td></tr>
<tr><td colspan="2">“File>Save Project”</td><td>“File>Save Library”</td></tr>
<tr><td>The relay will not provide this information unless the *.pep file is stored in the relay</td><td>The relay will not provide this information unless the *.pep file is stored in the relay.</td><td>The relay will not provide this information unless the *.pep file is stored in the relay.</td></tr>
<tr><td colspan="3">To store the logic configuration files in the relay use the “Communication>Upload info files to relay” option</td></tr>
<tr><td colspan="3">File storage inside the relay in a flash memory (RECOMMENDED):</td><td colspan="3">“Communication>Upload info files to relay” through Ethernet</td></tr>
<tr><td colspan="3">File Retrieval of relay hard disk stored files (RECOMMENDED):</td><td colspan="3">“Communication/Download info files from relay” through Ethernet</td></tr>
</table>

REMINDER:
Logic programming support files (*.pep, *.aut, *.lib) CANNOT be retrieved directly from the relay.
It is necessary * Either to have stored these files in the PC * Or to have uploaded previously the files into the relay (“***Communication>Upload info files to relay***”)

3.1.5 ENERVISTA 650 SETUP MENUS STRUCTURE

The EnerVista 650 Setup menus structure is shown in EnerVista 650 SETUP MENUS STRUCTURE.

Unless specified, options are available in both On-line and Off-line mode.

Options enabled only in On-line mode are marked as (*)

Options enabled only in Off-line mode are marked as (**)

The “***View > Language***” submenu allows the user to change the default language for the EnerVista 650 Setup program and it is only enabled when the relay is not communicating and no file has been opened.

Table 3–3: ENERVISTA 650 SETUP MENUS STRUCTURE

FILE	SETPOINT	ACTUAL	OPERATIONS (*)	COMMUNICATION	SECURITY	VIEW	HELP
Open (**)	Product Setup	Front Panel	NA	Computer	Login user	Traces	Instruction Manual
Save As (**)	System Setup	Status	NA	Modem (*)	Change Password	ModBus Memory Map	About EnerVista 650 Setup
Close (**)	Protection Elements	Metering	NA	Troubleshooting (*)	User Management	Languages (**)	
Config File Converter	Control Elements	Inputs/Outputs	NA	Calibration (*)			
Properties (**)	Inputs/Outputs	Records (*)	NA	Upgrade firmware version (*)			
Get info from relay (*)	Relay Configuration		NA	Upgrade operating system (*)			
Send info to relay (*)	Logic Configuration		NA	Upgrade F650 Web Server			
Print Setup (**)	Clock (*)		NA	Upload info files to relay			
Print Preview (**)			NA	Download info files from relay			
Print (**)			NA				
Print to file (**)			NA				
Exit			NA				

Table 3–4: GENERAL OVERVIEW OF FILE MENU:

FILE	
Open (**)	Open a settings and configuration file for off-line working.
Save As (**)	Save *.650 settings and configuration file.
Close (**)	Close the opened *.650 file in EnerVista 650 Setup.
Config File (*.650) Converter	Tool to convert the *.650 files from one version to another
Properties (**)	File properties for *.650.
Get info from relay (*)	Retrieve the *.650 settings and relay configuration compiled equations from the relay.
Send info to relay (*)	Send and write the *.650 settings and configuration to the relay.
Print Setup (**)	To configure printer settings.
Print Preview (**)	Preview of settings and configuration file printing format.
Print (**)	Launch the *.650 file to be printed.
Print to file (*.xls) (**)	*.650 printed to file in excel format.
Exit	Quit the application closing all the open windows.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.6.1 OPEN, SAVE AS AND CLOSE

In these options, the program opens a dialog box (with default path to Files>Config program folder) where the setting and configuration files can be selected for their “off-line” edition. For enabling access to this menu, there must be no communication between the PC program and the relay. (Mode off-line: “Communication>Computer>OFF”).

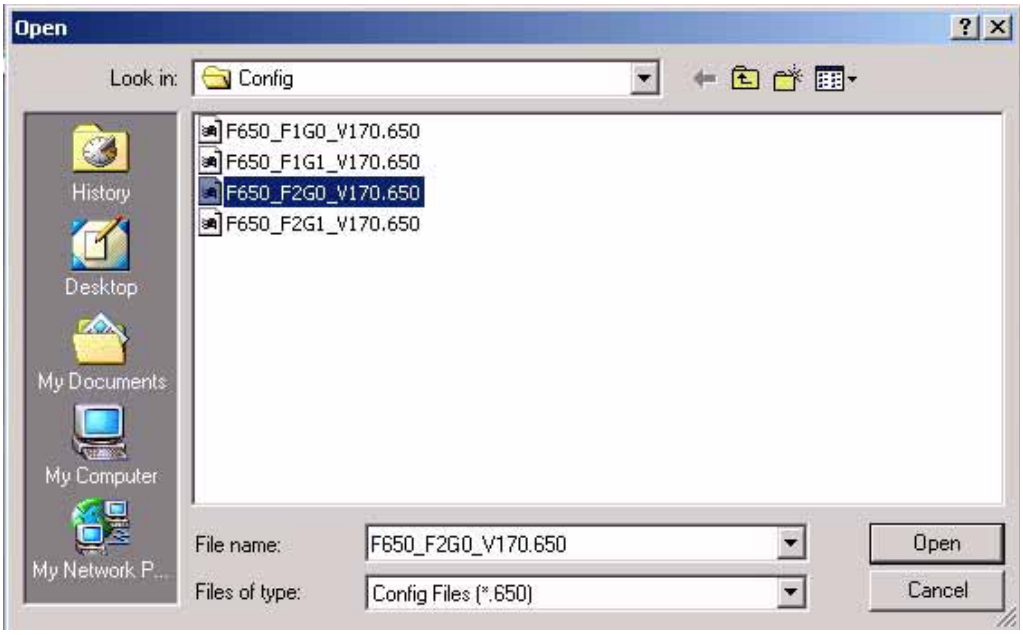


Figure 3–6: OPEN FILE MENU

Once the *.650 file with the appropriated relay model (FXGX) is selected, the program will enable the off-line options to fully program the unit. The enabled menus in the EnerVista 650 Setup program are: File, Settings, Actual, Communication, View and Help.

The off-line mode displays the File, Settings, Actual, Communication, View and Help submenus to program the unit.

The Actual values submenus are for structure purposes only Values are not refreshed while the relay is not communicating.

The “Save as” and ”Close” submenus are used to save the *.650 file into the computer and to close the current file. To work in off line mode for settings and configuration edition it is not necessary to use the ”Close” option, a new *.650 can be opened without closing the previous one. The ”Close file” option is used to clear all data in EnerVista 650 Setup program, enabling “Language”, ”Upload firmware” and “boot code” options.

3.1.6.2 CONFIG FILE (*650) CONVERTER

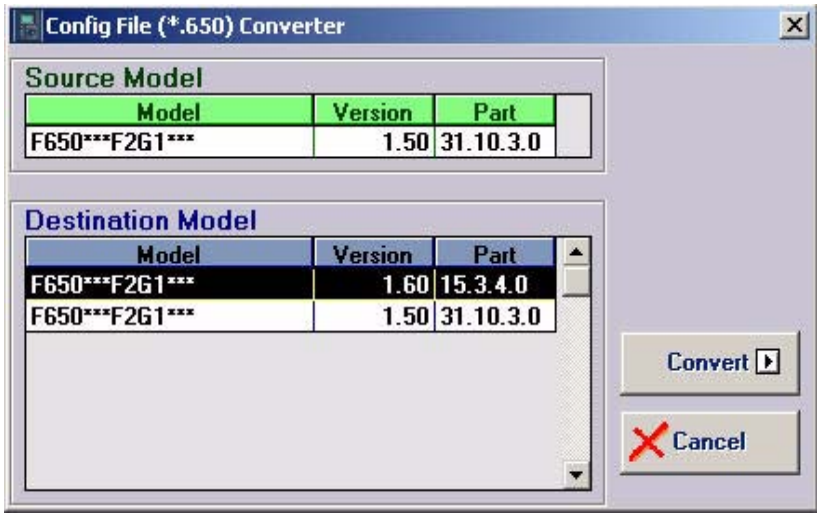


Figure 3–7: CONFIG FILE (*650) CONVERTER MENU

This tool provides automatic conversion of configuration files from a firmware version to a previous or later version.

Open the source *.650 file and select the version and model to be converted to.

It is possible to change the model type (FXGX) using the conversion tool. It must be taken into account that part of the logic can be readjusted to fit the new input and output boards selection. Notice also that the external wiring of inputs and outputs board are different for type 1, 2, 4 and 5.

3.1.6.3 PROPERTIES

When this option is selected, the program will show a screen including the relay model information, firmware version, etc. of the file being edited, as shown on Figure 3–8:

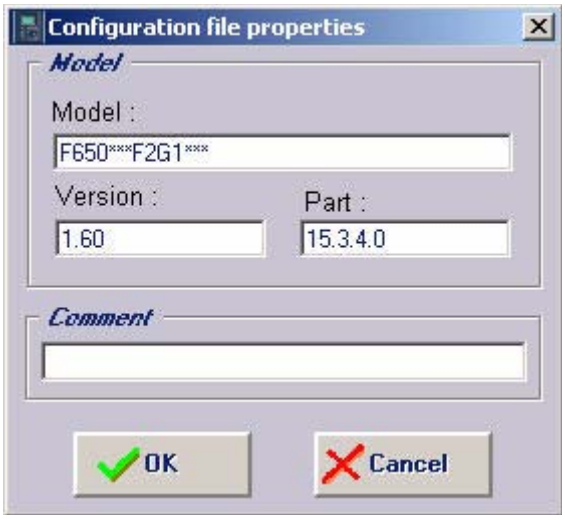


Figure 3–8: FILE PROPERTIES MENU

3.1.6.4 PRINTING OPTIONS (PRINT SETUP/PRINT PREVIEW/PRINT/PRINT TO FILE)

The printing options are active only in off-line mode, in “File edition”, and not in on-line mode, connected with the relay.

3.1.6.5 PRINT SETUP

Option to configure the printing options and settings for the printing device.

3.1.6.6 PRINT PREVIEW

Option to preview the whole settings and configuration file (*.650) in paper format to be printed as shown in Figure 3–9:.

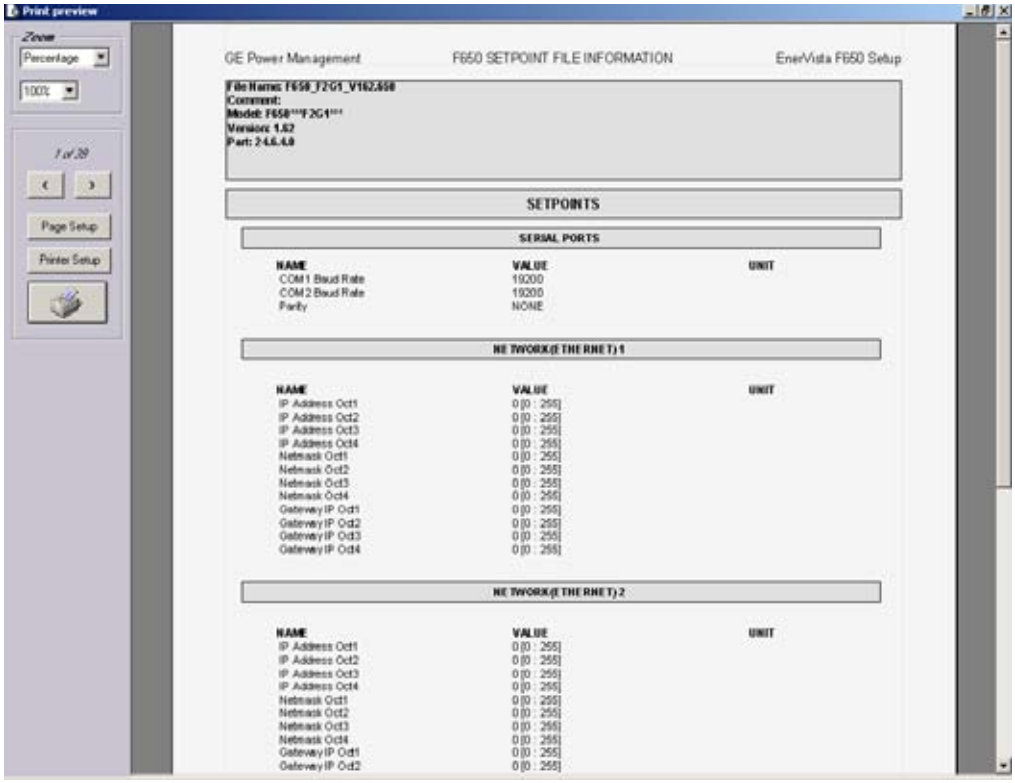


Figure 3–9: PRINT PREVIEW OF SETTINGS FILE

3.1.6.7 PRINT

In this option, the program will print the relay configuration using the PC default (active) printer on port COMx or LPT. This option is active only in off-line mode, in file edition, and not in on-line mode, connected with the relay.

3.1.6.8 PRINT TO FILE (*XLS)

Possibility to export the configuration file to an Excel file using the “Print to file (*.xls)” option.

Table 3–5: GENERAL OVERVIEW OF SETPOINT MENU IN ENERVISTA 650 SETUP:

SETPOINT	
Product Setup	Communications settings for all protocols and physical mediums. ModBus user map definition, fault report, oscillography, data logger and demand settings.
System Setup	General Settings, Flex Curves Definition, Breaker settings and maintenance, and switchgear snapshot events management.
Protection Elements	Phase, Neutral, Ground, Sensitive Ground and Negative Sequence Current Settings. Voltage Elements settings and Power Settings management.
Control Elements	Setting groups, under and overfrequency settings, synchrocheck, autoreclose, breaker failure, VT fuse failure, broken conductor and locked rotor settings management.
Inputs/Outputs	Contact I/O settings for all boards available in device, Remote Comms.
Relay Configuration	Configuration of Outputs, LEDs, Operations, Protection Elements, Oscillography, Operations, Control Events, Switchgear, Inputs, Virtual Inputs, Operations and HMI. Whole relay configuration with internal relay signals or user-definable ones as logic (virtual outputs).
Logic Configuration	Logic configuration graphic editor (PLC Editor). It is a PLC Project file editor that contains all the internal drawings used to make the logic (virtual outputs) based on IEC 61131-3 standard. Functional block diagram (FDB).
Clock (*)	Relay synchronization to computer clock or to user-definable date and time. On-line mode only.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.7.1 PRODUCT SETUP

Table 3–6: GENERAL OVERVIEW OF PRODUCT SETUP MENU:

PRODUCT SETUP	
Communication Settings	Serial Ports, Network (Ethernet), ModBus Protocol, DNP Slave and IEC 870-5-104 settings.
ModBus User Map	ModBus user map definition. The ModBus user map is formed by 256 records, selectable from the complete relay ModBus map.
Fault Report	Fault report settings. Possibility to show fault reports on HMI screen.
Oscillography	Oscillography settings (trigger position, samples per cycle, etc). The trigger and digital channels (up to 16) must be configured in "***Settings>Relay configuration***".
Data Logger	Data logger configuration
Demand	Demand settings. The demand trigger and demand reset signals must be configured in "***Settings>Relay configuration***"

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

e) COMMUNICATION SETTINGS

This section details the settings related to communication parameters for the different protocols available in the F650.

Table 3–7: GENERAL OVERVIEW OF COMMUNICATION SETTINGS MENU:

COMMUNICATION SETTINGS	
Serial Ports	Baud rate and parity for COM1 and COM2 serial communication ports.
Network (Ethernet)	Ethernet communication parameters for COM3 (IP Address, Netmask, Gateway IP, etc.) NOTE: The ModBus Slave address used by Ethernet ports is the one set for COM2.EnerVista 650 Setup software allows programming two different Ethernet addresses, but the first IP has always to be set as the second IP Address is an Alias.
ModBus Protocol	ModBus Slave Addresses for serial and Ethernet communication and the ModBus port number used for ModBus TCP/IP
DNP3 Slave	Physical port, Slave Address for DNP, IP Addresses for Masters, TCP/UDP Port, Unsolicited Response parameters, Analog scale factors and deadbands, message fragment size, Binary input block.
IEC 870-5-104,	TCP Port, Common Addr of ASDU, Cyclic Meter Period and, Synchronization Event settings.
SNTP (*)	Sinchronization over Ethernet settings

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.7.2 SYSTEM SETUP

This section shows the settings related to the system setup definition such as shown in the following table.

Table 3–8: GENERAL OVERVIEW OF SYSTEM SETUP MENU:

SYSTEM SETUP	
General Settings	This screen describes and enables the settings of the power system where the relay will operate. Some of these settings will be used only for metering values presentation purposes; however, some of them apply directly to the sampling and analog-digital conversion process (rated frequency setting). Therefore, these settings need to be adjusted so that they fit the system settings.
Flex Curves	Flex Curves – Programmable user curves: The relay incorporates 4 user curves called Flex Curve A, B, C and D. The points for these curves are defined by the user in "***Settings>System Setup>Flex Curves>Edit Curve***" menu in EnerVista 650 Setup. User defined flex curves can be selected as an operation curve in all the time overcurrent functions in the relay.
Breaker settings	Breaker settings, maintenance and switchgear selection of the device configured as breaker in the F650. The selected switchgear will be used in recloser, breaker failure and synchronism functions. The settings are Number of Switchgear, Maximum KI^2t, KI^2t Integ. Time, Maximum Openings, Max.Openings 1 hour.
Breaker maintenance	These settings correspond to the initialization of $(KI)^2t$ counters, and the counting of number of openings and closings of the switchgear configured as breaker. These Counters allow the breaker Maintenance. They are used to cumulate the breaker ageing produced by a trip or a breaker opening. In order to incorporate the breaker historic, in case of existing breakers, the system allows assigning an initial value to accumulated amperes, and to the number of opening and closing operations.
Switchgear	Configuration of snapshot events for each switchgear (enable or disable)

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.7.3 PROTECTION ELEMENTS

This option shows all the protection-grouped elements available in the relay as shown in Table 3–9:. Each of these groups includes the specific protection units of the same type. For example phase currents group includes TOC, IOC, directional units, etc. There are three groups available, so there are three protection units of each function that can work in grouped mode or ungrouped (altogether).

Table 3–9: GENERAL OVERVIEW OF PROTECTION ELEMENTS MENU:

PROTECTION ELEMENTS	
Phase Current	All overcurrent grouped functions for phase current.
Neutral Current	All overcurrent grouped functions for neutral current. (Calculated from phases, not measured)
Ground Current	All overcurrent grouped functions for ground current. (Measured from 4th current input)
Sensitive Ground Current	All overcurrent grouped functions for sensitive ground current. (Measured from 5th current input)
Negative Sequence Current	Negative sequence time overcurrent function
Voltage Elements	All under and overvoltage grouped functions for phases, neutral, auxiliary voltage and negative sequence.
Power	Forward and directional power grouped protection functions.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

Table 3–10: DIFFERENT PROTECTION ELEMENTS INCLUDED

PHASE CURRENT		
	Phase TOC High	Phase time overcurrent, high level (51PH)
	Phase TOC Low	Phase time overcurrent, low level (51PL)
	Phase IOC High	Phase instantaneous overcurrent, high level (50PH)
	Phase IOC Low	Phase instantaneous overcurrent, low level (50PL)
	Phase Directional	Phase directional unit (67P). Quadrature Voltage for polarization
	Thermal Model	Thermal model or Thermal image unit for phases (49)
NEUTRAL CURRENT		
	Neutral TOC	Neutral time overcurrent (51N)
	Neutral IOC	Neutral instantaneous overcurrent (50N)
	Neutral Directional	Neutral directional unit (67N). Voltage, current and dual polarization.
GROUND CURRENT		
	Ground TOC	Ground time overcurrent (51G)
	Ground IOC	Ground instantaneous overcurrent (50G)
	Ground Directional	Ground directional unit (67G). Voltage, current and dual polarization.
SENSITIVE GROUND CURRENT		
	Sensitive Ground TOC	Sensitive ground time overcurrent (51SG)
	Sensitive Ground IOC	Sensitive ground instantaneous overcurrent (50SG)
	Isolated Ground IOC	Isolated ground overcurrent (50IG)
	Sensitive Ground Directional	Sensitive ground directional unit (67SG)
NEGATIVE SEQUENCE CURRENT		
	Negative Sequence TOC	Negative sequence time overcurrent (46P)
VOLTAGE ELEMENTS		
	Phase UV	Phase undervoltage (27P)
	Phase OV	Phase overvoltage (59P)
	Neutral OV High	Neutral overvoltage, high level (59NH)
	Neutral OV Low	Neutral overvoltage, low level (59NL)
	Negative Sequence OV	Negative sequence overvoltage (47)
	Auxiliary OV	Auxiliary overvoltage (59X)
	Auxiliary UV	Auxiliary undervoltage (27X)
POWER		
	Forward Power	Forward power (32FP), in primary values.
	Directional Power	Directional power (32), in primary values.

3.1.7.4 CONTROL ELEMENTS

This option shows all the control elements available in the relay as shown in Table 3–11:. Some of the elements are grouped ones such as underfrequency, overfrequency and broken conductor.

Table 3–11: GENERAL OVERVIEW OF CONTROL ELEMENTS MENU:

CONTROL ELEMENTS	
Setting Group	F650 units incorporate a flexible grouping capability for protection units. This means that protection units can be used in either single setting group (default mode-all units can operate simultaneously) or three setting groups (in this mode, protection units are grouped in three independent tables, with only one of them active at a given time). Protection element grouping involves only Protection elements together with broken conductor detection and over and under frequency, which are usually considered as control elements. The rest of control elements such as recloser, fuse failure, breaker failure, synchronism, and breaker settings are not involved in the tabled groups concept.
Underfrequency	Underfrequency unit (81U). Grouped element
Overfrequency	Overfrequency unit (81O). Grouped element
Synchrocheck	Synchronism check unit (25). Not grouped, a single unit provided
Autoreclose	Recloser (79). Not grouped, a single unit provided
Breaker Failure	Breaker failure (50BF). Not grouped, a single unit provided
VT Fuse Failure	Fuse Failure (VTFF). Not grouped, a single unit provided
Broken Conductor	Broken or fallen conductor detection function (I2/I1). Grouped element. Ratio between the negative sequence current, I2, and the positive sequence current I1. In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio is increased.
Locked Rotor	Locked rotor detection function (48). Grouped element.

3.1.7.5 INPUT/OUTPUTS

Section that contains the settings for all input and output boards and the Force Outputs and Virtual inputs activation tools.

Table 3–12: GENERAL OVERVIEW OF "INPUTS/OUTPUTS" SETTINGS MENU.

INPUTS/ OUTPUTS	
Contact I/O	Inputs and outputs settings for all boards in F650. The I/O settings configuration can only be performed through EnerVista 650 Setup, not HMI available.
Force Outputs (*)	This menu allows activating each contact output in the relay, to facilitate maintenance testing. On line mode only.
Virtual Inputs (*)	This menu allows operating virtual inputs. These variables are used as inputs to logic schemes configured in the relay. Virtual inputs can be operated in a latched mode (32 latched virtual inputs) or in Self-reset mode (32 self reset virtual inputs).
Remote Comms.	This menu allows configuring remote inputs coming from other devices through GSSE messages.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

This section shows the settings related to inputs and outputs for the different boards available in F650 (F, G, H, J).

Table 3–13: GENERAL OVERVIEW OF "INPUTS/OUTPUTS>CONTACT I/O" SETTINGS MENU.

CONTACT I/O	
Board F	Board located in first slot, always connected, either type 1 or 2.
Board G	Board located in second slot, depends on model definition. If model is type G0 there is no board in second slot.
Board H	Board located in first slot of CIO Module (external inputs/outputs module)
Board J	Board located in second slot of CIO Module (external inputs/outputs module)

3.1.7.6 RELAY CONFIGURATION

This is the relay configuration section in which the relay can be configured using internal states or already compiled equation on PLC Editor.

Table 3–14: GENERAL OVERVIEW OF RELAY CONFIGURATION MENU:

RELAY CONFIG	
Outputs	Configuration of contact output operate and reset signals for all boards.
LEDs	15 LEDs fully configurable from any logical variable, contact or virtual input. First 5 LEDs are latched by hardware, the rest are self-reset but can be latched through PLC configuration. From the LED configuration screen, it is possible to print the vertical LED label for the relay
Operations	Configurable operations up to 24. Operation texts, interlocks, final states, frontal keys, time outs and masters.
Protection Elements	This tab allows assigning operands (logic signals) as inputs to different protection elements. To block, reset, initiate the different protection elements inputs.
Oscillography	Trigger and up to 16 digital channels to be included in oscillography records, are programmable from any logical variable, contact or virtual input. Text configuration is only for off-line mode. **NOTE:** This screen is used for the configuration of digital channels and oscillography trigger. The rest of parameters, such as function enabling/ disabling, sampling rate, number of oscillography files, etc. must be set on the **Settings>Product Setup>Oscillography** menu.
Control Events	Up to 128 user programmable events from any logical variable, contact or virtual input. Possibility to display the event as an alarm on the alarms panel. Control events are also displayed in the snapshot events recording. 1 ms time tagging. A control event is a logic signal associated to an operand or combination of operands, that allows following the status of that signal.
Switchgear	Up to 16 configurable switchgear elements. A switchgear element can be a breaker, a line selector switch, a grounding selector switch, a busbar selector switch, etc. This screen allows configuration of type of contacts, opening and closing time, contact assignation and text for events related to switchgear. There are 64 pre-established events for switchgear, which correspond to opening, closing, Error01 and Error11 of the 16 programmable switchgear elements.
Remote outputs	Up to 32 DNA bits and 6?????? bits to be transmitted to remote devices over CAN using GSSE messages
Inputs	Text configuration for off-line mode file management for all the contact inputs available in device.
Virtual Inputs	Text configuration for off-line mode file management. 32 latched and 32 self reset virtual inputs.
MMI (HMI-Human Machine Interface)	Screen for one line diagram configuration. This menu shows a scenario to draw a simplified one-line diagram of a bay in a feeder, line, transformer, etc. The menu includes a library for power elements, metering elements, text and drawings. See an example in Figure 3–11:

The following figures show an example of the default factory configuration for F650.

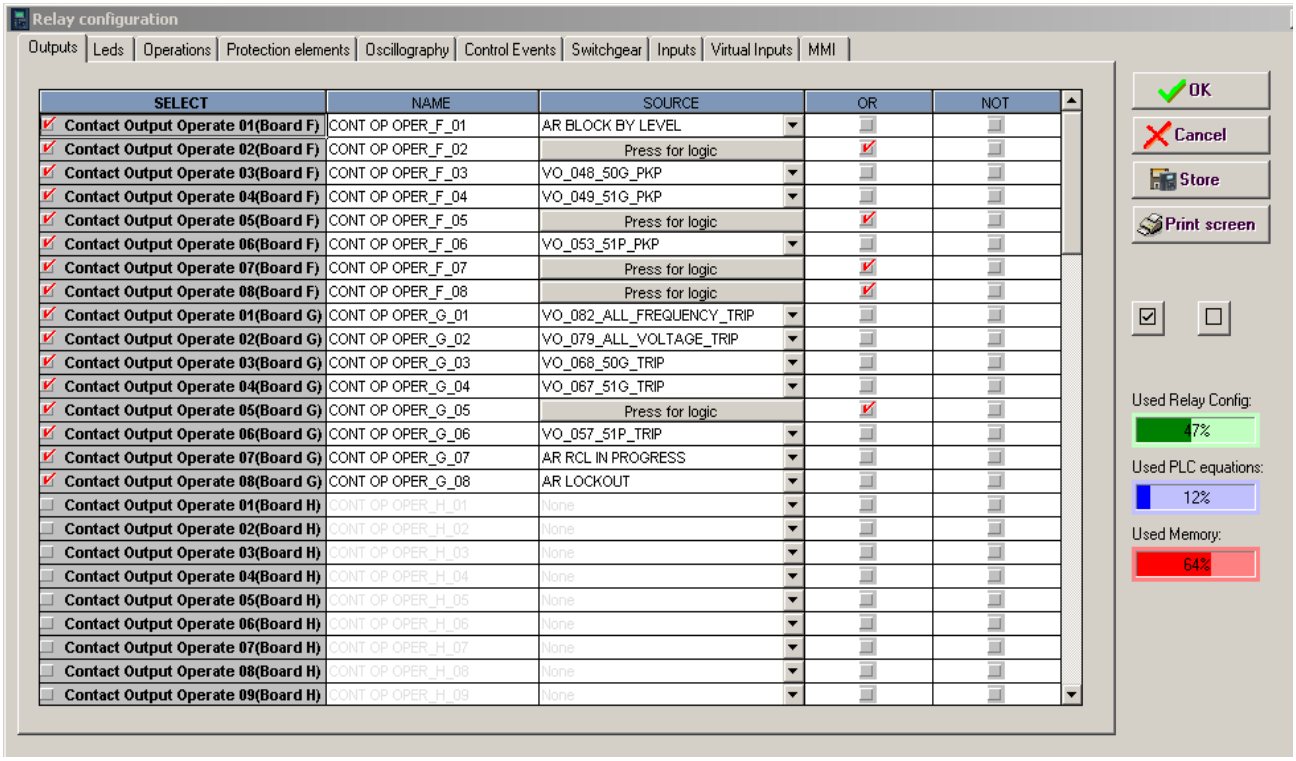


Figure 3–10: RELAY CONFIGURATION

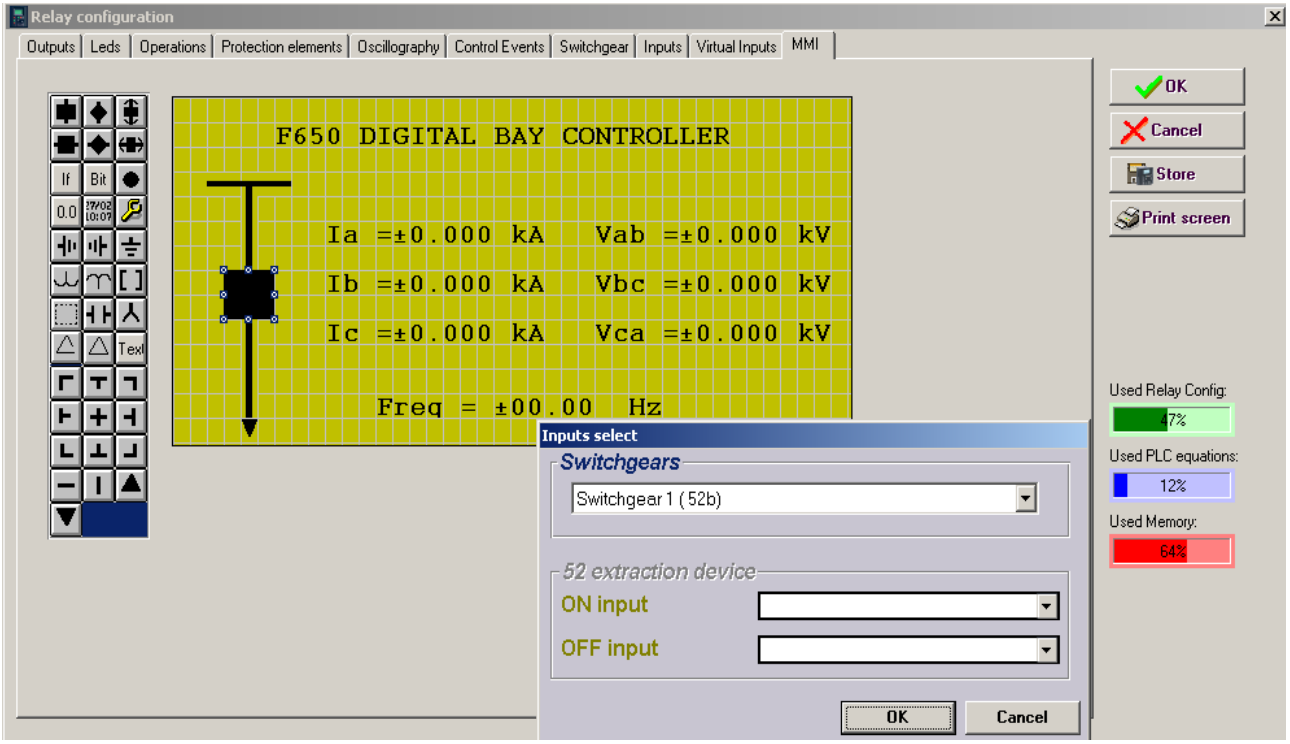


Figure 3–11: HMI CONFIGURATION

3.1.7.7 LOGIC CONFIGURATION

This logic configuration allows creating more complex configurations, using the graphical PLC, than using the tables from Relay Configuration. For file management detailed information go to section 3.1.4.

Table 3–15: GENERAL OVERVIEW OF LOGIC CONFIGURATION MENU:

LOGIC CONFIG		
	*.pep	Header for Logic project: PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.
	*.aut	PLC Project file containing all the drawings used by the logic, required by F650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).
	*.lib	User programmable logic objects: Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.

3.1.7.8 CLOCK

This menu allows to update the date and time of the relay, either synchronizing them with the PC clock, or entering the information manually.

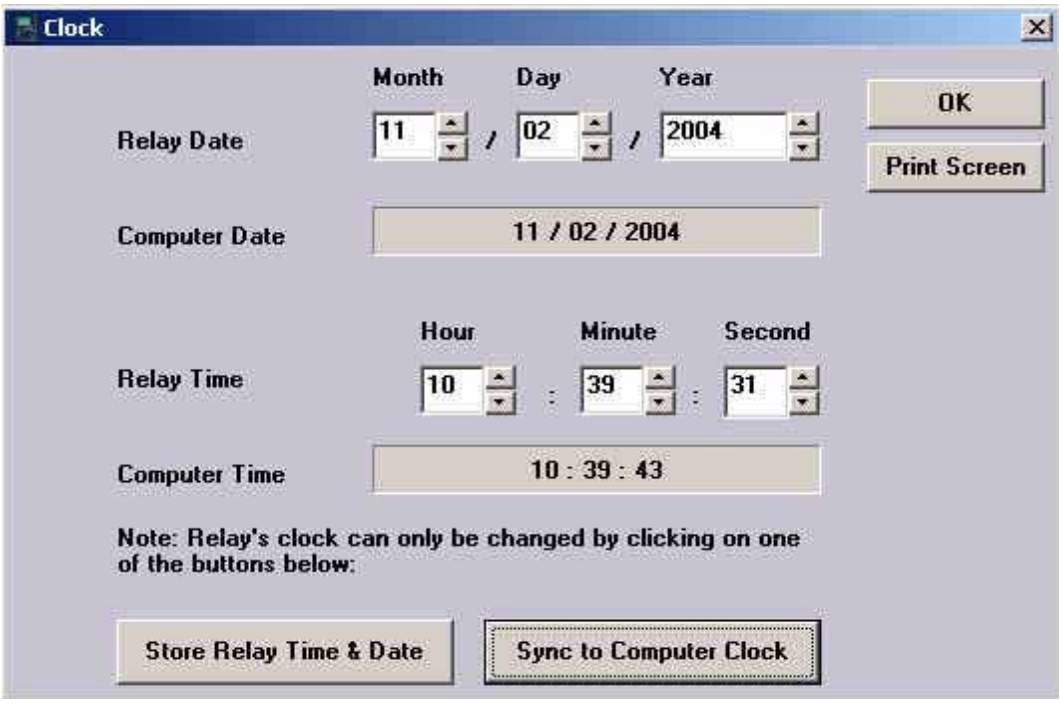


Figure 3–12: CLOCK

3.1.8 ACTUAL VALUES MENU OVERVIEW

The menu bar in the main screen of EnerVista 650 Setup software shows the ACTUAL menu option. This option concentrates and displays all the status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc. This section shows only the structure of menus in EnerVista 650 Setup.

Table 3–16: GENERAL OVERVIEW OF ACTUAL VALUES MAIN MENU:

ACTUAL		
	Front Panel>LEDs	The relay front LEDs status is shown on this menu.
	Status	Protection and control status signals for all available protection functions in device.
	Metering	All metering values available in device. Primary and secondary values, frequency and phasor diagram provided.
	Inputs/Outputs	All input and output status provided. For contact inputs and contact outputs as well as virtual input and virtual output signals.
	Records	Only enabled in on line mode, retrieval of all the available records in device. Snapshot events, control events, oscillography and fault reports.

3.1.8.1 FRONT PANEL

The front panel menu shows only the LEDs submenu where all the front LEDs can be monitored.

3.1.8.2 STATUS

The following menu includes all the available protection status in the device.

Table 3–17: GENERAL OVERVIEW OF STATUS MENU:

STATUS	
Operation bits	Up to 24 elements. OPERATION BIT XX is (0) when the configured time out for the operation XX expires or when success conditions are met. And it is (1) if operation XX is executed and interlocks are fulfilled.
Breaker	Breaker status (open, closed or undefined). The rest of the status signals corresponding to the switchgear XX configured as breaker are in the "***Status>Switchgear Status>Switchgear XX***" menu.
Protection	Status of all the protection units in the device.
Control Elements	Status of all the control units available in the device.
Protection Summary	This screen shows a complete list of all protection and control elements in the relay, showing their status (enabled or not).
Snapshots events summary	Summary of the snapshot events status (enabled or disabled) for protection, control, inputs and outputs boards and switchgear.
ModBus User Map	Up to 256 elements. Value in SIGNED INT 16 BIT format of the reading for the selected address configured in "***Settings>Product Setup>ModBus User Map***"
Switchgear Status	Up to 16 blocks of switchgear status signals for the 16 configurable devices. Status signals such as inputs for A and B contacts, status for A and B, open and close status, error 00 and error 11, open init and close init, fail to open and fail to close signals.
Calibration	Internal states for calibration. Factory calibration and calibration error signals.
Flex Curves	Flex curve status for A, B, C and D user curves. (0) if it is not configured, (1) if it is configured. To configure a flex curve go to "***Settings>System Setup>Flex Curves***" menu.
System Info	This screen can monitor the system parameters and the internal status of the Relay boot code. Not enabled by default, password required
Records Status	Information related to the different records stored in the Relay, such as: Fault reports, control events, oscillography, data logger, demand, energy, and breaker maintenance.
SNTP-IRIG-B	Information related to synchronization via IRIG_B or SNTP

Table 3–18: DIFFERENT CONTROL ACTUAL VALUES INCLUDED IN THE CONTROL ELEMENTS MENU

CONTROL	
Frequency	Status signals (pickups and operations) for under and overfrequency units.
Synchrocheck	Status signals for synchrocheck function (25).
Autoreclose	Status signals for autoreclose function (79). Close signal, recloser status (ready, lockout, etc), block signals after each shot.
Breaker Failure	Status signals for breaker failure function (50BF).
VT Fuse Failure	Fuse failure detection signal.
Broken Conductor	Status signals (pickups and operations) for broken conductor (I2/I1).
Setting Groups	Status signals (activations and blocks) for the relay setting group change. By default the "setting group" setting is disabled and all the grouped elements can be enabled at the same time.
Locked Rotor	Status signals (pickups and operations) for locked rotor units.

Table 3–19: DIFFERENT PROTECTION ACTUAL VALUES INCLUDED IN THE PROTECTION MENU

PROTECTION	
Protection Blocks	This screen shows all the protection element blocks available. Protection elements block signals can be configured at "***Settings>Relay Configuration > Protection Elements***".
Phase Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for phase current.
Neutral Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for neutral current (calculated from phases).
Ground Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for ground current (measured from 4^{th} current input).
Sensitive Ground Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent, isolated and directional protection functions for ground current (measured from 4^{th} current input).
Negative Sequence Current	Protection status signals (pickups and operations) for negative sequence time overcurrent function.
Thermal Model	Protection status signals for thermal model. Reset, alarm and operation signals for phases and for unit, besides the thermal image values in percentage for all phases and units.
Voltage	Protection status signals (pickups and operations) for all voltage functions, undervoltage, overvoltage, neutral overvoltage, negative sequence overvoltage and auxiliary under and over voltage.
Power	Protection status signals (pickups and operations) for forward and directional power units.

Table 3–20: SHOWS THE ACTUAL VALUES RELATED TO RECORDING FUNCTIONS IN THE RECORDS STATUS MENU:

RECORD STATUS	
Fault Reports	This menu shows the fault report status signals, as fault report trigger, fault date, fault type and location, besides the fault report number.
Control Events	Status of the control events (if the signal configured to launch the control event is active or not).
Oscillography	Status of signals related to oscillography recording, such as status or digital channels, oscillography trigger, number of records available, etc.
Data Logger	Data logger information about oldest and newest sample time stamp, and number of channels and days configured in data logger settings.
Demand	Demand trigger and reset inputs status.
Energy	Freeze, unfreeze and reset input signals for energy counters.
Breaker Maintenance	All signals related to breaker maintenance, such as number of openings, closings, $(KI)^2t$ counters, alarm signal for $(KI)^2t$, etc.

3.1.8.3 METERING

The Metering menu includes all the measurements available in the device. Primary and secondary values, and also the data related to the recording functions in the relay.

Table 3–21: GENERAL OVERVIEW OF METERING MENU:

METERING		
	Primary Values	Primary values measurements for currents, voltages, power, energy and demand
	Secondary Values	Secondary values measurements for currents, voltages and power.
	Phasor Diagram	Current, voltage and sequence components.
	Frequency	Line and Bus frequencies.

3.1.8.4 INPUTS/OUTPUTS

The Inputs/Outputs menu includes all the inputs and outputs signals available in the device. Contact and virtual type.

Table 3–22: GENERAL OVERVIEW OF INPUTS/OUTPUTS MENU:

INPUTS/ OUTPUTS		
	Contact Inputs	Status of digital inputs in the Relay for each board according to the relay model.
	Contact Output Status	Status of digital outputs in the Relay for each board according to the relay model.
	Contact Outputs Operates	Status (activated or not) of the variables used to operate a contact output. To configure these signals go to “Settings>Relay Configuration>Outputs” menu.
	Contact Outputs Resets	Status (activated or not) of the variables used to reset a contact output. To configure these signals go to “Settings>Relay Configuration>Outputs” menu. This output reset Command will only be effective if the “***latch***” option has been Selected for the “***Output Type***” setting on the I/O board, thus when the contact output has been configured to emulate function 86 (latching relay).
	IO Board Status	Status of I/O boards. This status provides if the hardware it is OK (boards matching relay model, correctly inserted in their tracks, in good state and communicating through the internal CAN Bus).
	Virtual Inputs	Status of Virtual inputs latched (32) and self-reset (32).
	Virtual Outputs	Status of virtual outputs (configured in PLC Editor). Up to 512.
	Remote Outputs	States of remote outputs
	Remote Inputs	Status of remote device and remote inputs
	Analog Inputs (*)	Measurements coming from analog inputs (DCMA)

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.8.5 RECORDS

The Records menu is only available in on line mode and includes the possibility to retrieve all the records available in the device. By serial or Ethernet.

Table 3–23: GENERAL OVERVIEW OF RECORDS MENU:

RECORDS (*)		
	Event recorder (*)	Retrieval and visualization of snapshot event (all and new), control events and alarm panel. By serial or Ethernet (ModBus RTU or TCP/IP)
	Waveform capture (*)	Retrieval of oscillography files, by serial or Ethernet.
	Fault Report (*)	Retrieval and visualization of fault report files, by serial or Ethernet.
	Data logger (*)	Retrieval and visualization of data logger files. Only by Ethernet.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.9 OPERATIONS MENU OVERVIEW

Option only available in on line mode, showing all the operations previously configured in the relay with their corresponding texts.

Table 3–24: GENERAL OVERVIEW OF OPERATIONS MENU:

OPERATIONS	
Operation 1 (*)	Entry to first operation (with its corresponding text)
...	...
Operation 24 (*)	Entry to 24th operation (with its corresponding text)

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.10 COMMUNICATION MENU OVERVIEW

The communication menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, boot code, web server and other file storing capabilities (upload and download info files to/from relay).

For more detail information go to section starting communication for communication menus description and refer to the flash memory update procedures.

Table 3–25: GENERAL OVERVIEW OF COMMUNICATION MENU:

COMMUNICATION	
Computer	Menu to start communication with the relay.
Modem (**)	Menu to set modem communication parameters (only available if control type is set to modem in computer menu).
Troubleshooting (*)	Menu that Lets the user to perform reading or writing in ModBus addresses, for verifying communications and access to different positions in the ModBus memory map.
Calibration (*)	Retrieval and store calibration settings from/to relay.
Upgrade firmware version (**)	Menu to update the relay firmware version through Ethernet
Upgrade boot code (**)	Menu to update the relay boot code (front RS323 and Ethernet connection)
Upgrade F650 web server	Menu to update the web server application (if available)
Upload info files to relay	Hard disk storage of settings and configuration files on the relay.
Download info files from relay	Retrieval of settings and configuration files that had been previously stored in the relay hard disk.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.11 SECURITY MENU OVERVIEW

The security menu includes all the menus related to security control in EnerVista 650 Setup. EnerVista 650 Setup security users and passwords are not related to passwords in HMI. Each security level has its own access for HMI management and EnerVista 650 Setup management.

Table 3–26: GENERAL OVERVIEW OF SECURITY MENU:

SECURITY	
Login User (*)	Log on menu for EnerVista 650 Setup. Enabled after security control has been enabled in user management menu.
Change Password (*)	Menu to change passwords and establish password recovering questions.
User Management (*)	User management dialog box.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.12 VIEW MENU OVERVIEW

The view menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, boot code, web server and other file storing capabilities (upload and download info files to/ from relay).

The ModBus memory map is detailed in the complete instruction manual (English only) and can be obtained from EnerVista 650 Setup program.

Table 3–27: GENERAL OVERVIEW OF VIEW MENU:

VIEW	
Traces (*)	To inspect ModBus communication traces between the EnerVista 650 Setup and the relay.
ModBus Memory map	Complete ModBus memory map description.
Languages (**)	Option to change the EnerVista 650 Setup default language. Only available if the relay is not communicating and no file (*650) is open.

Options enabled only in On-line mode are marked as (*). Options enabled only in Off-line mode are marked as (**)

3.1.13 HELP MENU OVERVIEW

Complete instructions manual and data about EnerVista 650 Setup release.

Table 3–28: GENERAL OVERVIEW OF HELP MENU:

HELP	
Instructions Manual	Instructions manual in the language selected in “View>Languages” menu.
About EnerVista 650 Setup	Release version and date of EnerVista 650 Setup program.

The HMI interface consists of several functional panels. The faceplate can be unscrewed to allow easy access to the removable modules. There is also a removable dust cover that fits over the display and other cover that protects the front RS232 Communications port and the commands buttons that can be sealed. The following figure shows the HMI in F650.

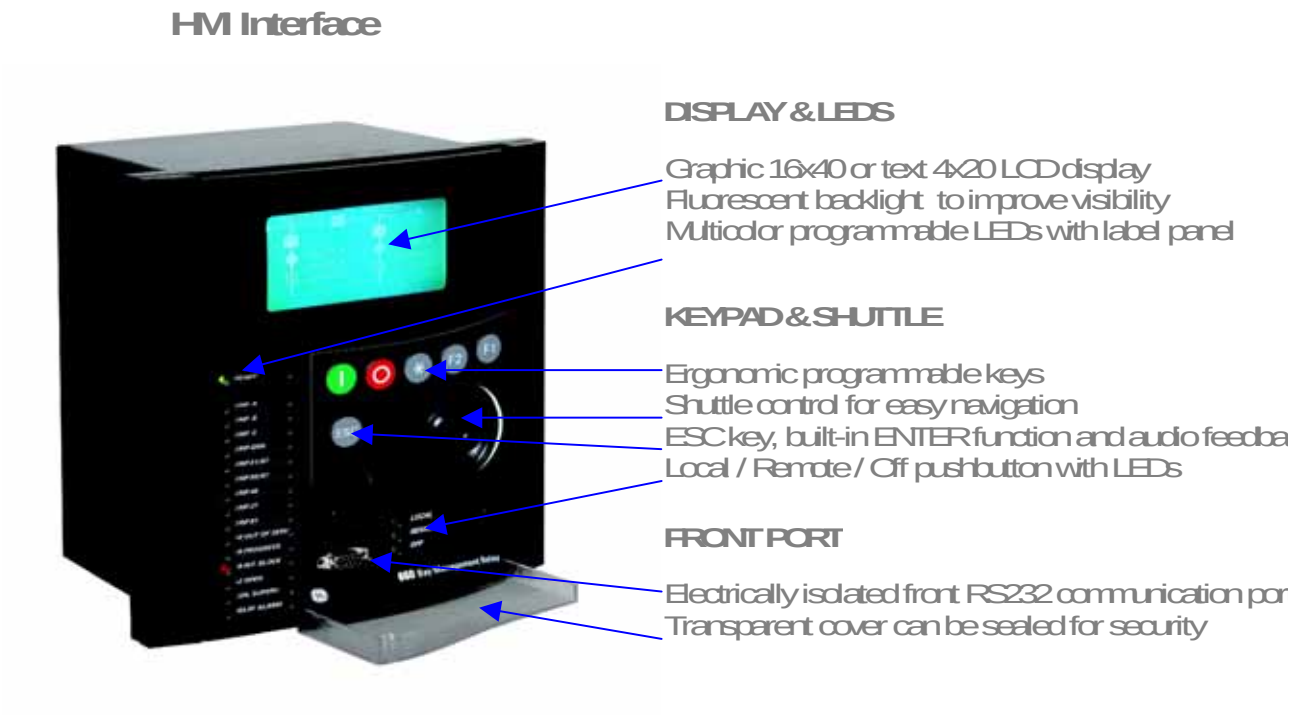

HMI Interface
DISPLAY & LEDS
Graphic 16x40 or text 4x20 LCD display
Fluorescent backlight to improve visibility
Multicolor programmable LEDs with label panel
KEYPAD & SHUTTLE
Ergonomic programmable keys
Shuttle control for easy navigation
ESC key, built-in ENTER function and audio feedba
Local / Remote / Off pushbutton with LEDs
FRONT PORT
Electrically isolated front RS232 communication por
Transparent cover can be sealed for security

Figure 3–13: HMI INTERFACE

3.2.1 DISPLAY

F650 units are available with two different options for the front display. The first option is an alphanumerical display of 4 lines with 20 characters each, and the second option is a graphical display of 16 lines with 40 characters each (128x240 pixels), being B the ordering code option for the text display model (basic), and M the code for the mimic display (graphical).

The boot code and firmware versions can be seen in the relay text main screen, this screen is the default screen in the text menu for all models: After the text “F650”, appears the relay firmware version (2.00 in the example), and between brackets the boot program version (3.0 in the example), followed by “ General Electric”, the relay model and the default front RS232 port (COM2) communication parameters.

Figure 3–14: TEXT MAIN SCREEN

3.2.2 FRONT LED INDICATORS

The relay provides 16 LED indicators, 15 user programmable plus one non-configurable LED (READY) that shows if the relay is in service.

Programmable LEDs are divided into groups of 5 LEDs, each of the groups having a different color. The first group of LED indicators is latched by hardware (red color ones), usually configured for trip signals. The second group (yellow color) and third group (green color) of LED indicators are self-reset type and will be reset once the condition has been cleared, but can be latched using logic through PLC configuration.

The ESC key is used to reset any latched led indicator, once the condition has been cleared. Keep the ESC button pressed for more than 3 seconds; all LEDs will light up, verifying their correct operation. When releasing the ESC key, all indicators programmed with memory, such as tripping LEDs, will be reset.

The latched conditions can also be reset via communications using the LED reset input (to configure this signal go to "***Settings>Relay Configuration>Protection elements>LED RESET INPUT***"). By default this LED reset input signal is set to LEDS RESET operation.

3.2.3 PUSHBUTTONS

The front panel provides:

Push buttons: keypad (5 user programmable plus ESC non configurable), shuttle key or shuttle key for easy navigation, command pushbutton to select operations mode.

RS232 port: intended for connection to a portable PC.

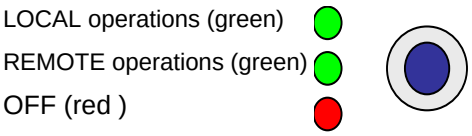
3.2.3.1 KEYPAD AND SHUTTLE KEY

This button can be used for closing the user programmable switchgear. It is fully programmable by the user.
This button can be used for closing the user programmable switchgear. It is fully programmable by the user.
User programmable
User programmable
User programmable
(ESC) Escape key. When pressed during more than 3 seconds, it will test all LEDs and reset the trip LEDs.
shuttle key or Shuttle Key (it can be both rotated and pressed): Used for selecting menus, submenus, settings and for confirmation. Press or rotate the shuttle key to enter the text main menu from the text standby screen.

Figure 3–15: KEYPAD AND SHUTTLE KEY DESCRIPTION

3.2.3.2 COMMAND PUSH BUTTON

The unit incorporates a command pushbutton located at the bottom right side of the faceplate, with three options: local, remote, and off. The first option (LOCAL) allows executing operations in local mode (HMI, front RS232 port, and rear COM2 port). The second option (REMOTE) allows operation execution only through remote communications (COM1 and COM3 - Ethernet). The third option (OFF) blocks the execution of operations. Each position is identified with an LED indicator, as follows:



Press the command button to switch from local to remote operations mode and vice versa. OFF status (operation inhibited for maintenance and safety) can be reach pressing the commands pushbutton during several seconds (local-remote-off sequence).

3.2.4 FRONT PORT AND COVER SEALING SYSTEM

Figure 3–16: shows the detail of the front RS232 communication port and local/remote button access cover sealing system. The sealing system is similar to the one used in energy meters, using wire and plumb seal.

High quality plastic have been used in the design to withstand extreme environmental conditions, both mechanical and electrical, sun radiation, humidity, etc. in order to guarantee a long life for the unit.

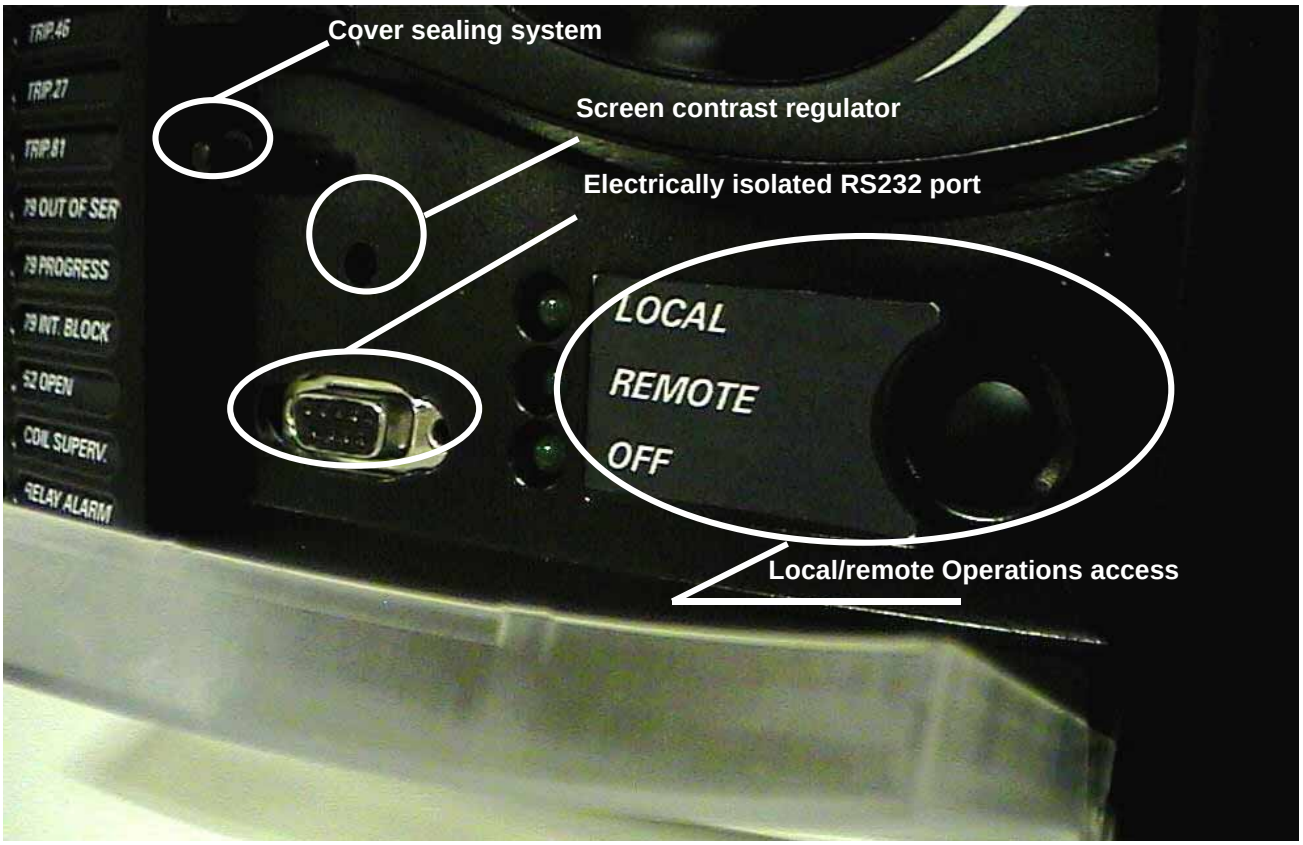


Figure 3–16: DETAIL OF FRONT PORT AND COVER SEALING SYSTEM

3.2.5.1 NAVIGATION IN TEXT MENU

Text menu is available for all models, this is the main menu for visualizing actual values, metering, changing settings, etc. through the HMI. In models with graphical display (M in ordering code) besides this text main menu there are several screens providing more performance for control purposes.

Press (or rotate left or right) the shuttle key to enter the main menu, starting from the standby screen (default main screen). The default main screen can be accessed pressing ESC key till it appears. In all the navigation Press the shuttle key to select the desired header display (top-level menu). Each press of the shuttle key advances through the main heading pages as illustrated below. To return to previous menus press the ESC key. To move inside the top-level menu without changing to other low levels, rotate the shuttle key left to move up and right to move down.

When rotating the shuttle key the selected menu is marked by a single scroll bar character. The mark (**>**) in the right part of any menu means that contains more than one level.

Symbol	Action performed	Navigation in menu
⇒	Press Shuttle Key	Enter next level
⇐	Press Esc Key	Exit to previous level
L–R	Rotate Shuttle Key	move up and down in the same level
L	Rotate Left Shuttle Key	move up in the same level
R	Rotate Right Shuttle Key	move down in the same level
■	Menu selection	Menu selection
>	More menus to display	More menus to display

Figure 3–17:shows an example of main menu navigation:

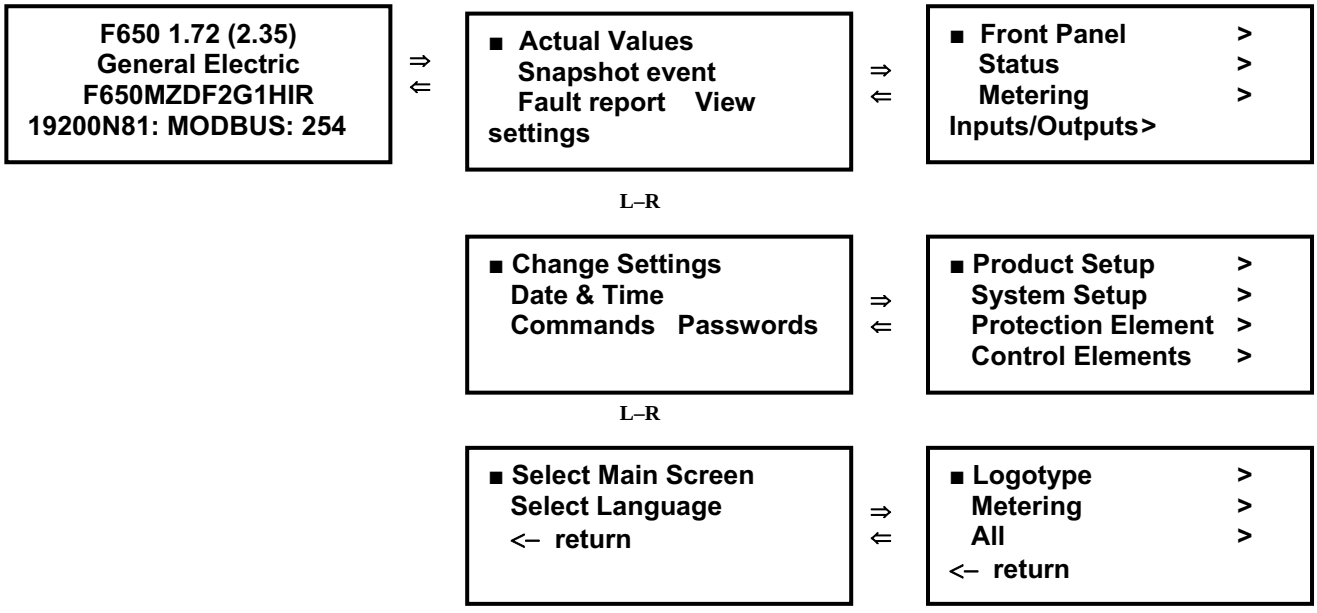


Figure 3–17: NAVIGATION IN MAIN TEXT MENU

3.2.5.2 TEXT MENU HIERARCHY

The structure of HMI text menu is similar to the EnerVista 650 Setup in the actual values and settings (view and change) menus.

The main menu shows the following options:

Table 3–29: GENERAL OVERVIEW OF MAIN TEXT MENU:

NAME	DESCRIPTION	NAVIGATION IN MENU
Actual Values	Actual values of all the signals available in device. Status of protection and control elements, measurements, inputs and outputs, etc.	Press shuttle key to enter next level. Press ESC to return to default main screen.
Snapshot events	Visualization of all snapshot events in text mode (two screens for each snapshot event). In graphical displays there can be seen in a dedicated screen.	Press shuttle key to visualize snapshot events in text menu. Press ESC to return to default main screen.
Fault Report	Fault reports information available in HMI (two screens for each fault report)	Press shuttle key to enter next level. Move L-R to see all the available fault reports in device. Press shuttle key to enter particular information for fault report selected.
View Settings	Visualization of all protection and control settings available in device.	Press shuttle key to enter next level. Move L-R to select submenu. Press ESC to return to previous level.
Change Settings	Menu that allows changing all protection and control settings available in device. Inputs and outputs settings, relay configuration and logic configuration are not available in HMI, only via EnerVista 650 Setup software.	Press shuttle key to enter next level. Move L-R to select submenu. Press esc to return to previous level.
Date & Time	Date and time visualization and modification by user	First mode is visualization. Press again shuttle key to start modification in date and time. Press ESC to return to previous level.
Commands	Operations execution in local mode.	Move L-R to pre select operation. Press shuttle key to select and confirm. Press ESC to return to previous level.
Password	Password menu for settings and commands	Move L-R to select submenu. Press shuttle key to enter next level. Press ESC to return to previous level.
Select Main Screen	Selection of default main screen in text menu.	Move L-R to select the default main screen type. Press shuttle key to confirm.
Select Language	Language selection. Between default language (see ordering code) and English.	Move L-R to select the default language. Press shuttle key to confirm selection. Switch the relay off and on.
< - return	Return to previous level	Press shuttle key to return to previous level.

a) ACTUAL VALUES

The Actual Values menu option in HMI concentrates and displays all the status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc.

Table 3–30: GENERAL OVERVIEW OF ACTUAL VALUES MAIN MENU:

Front Panel >		
	LEDs	
Status >		
	Operation Bits	
	Breaker	
	Protection >	
		Protection Blocks
		Phase Current
		Neutral Current
		Ground Current
		Sens. Ground Current
		Neg. Seq. Current
		Thermal Model
		Voltage
		Power
	Control Elements >	
		Frequency
		Synchrocheck
		Autoreclose
		Breaker Failure
		VT Fuse Failure
		Broken Conductor
		Setting Groups
		Locked Rotor
	Switchgear Status >	
		Switchgear 1
		Switchgear ...
		Switchgear 16
	Calibration	
	Flex Curves	
	System Info	
	SNTP/IRIG_B	
	Records Status >	
		Fault Reports
		Control Events
		Oscillography
		Data logger
		Demand
		Energy
		Breaker Maintenan.
Metering >		
	Primary Values >	
		Current
		Voltage
		Power
		Energy
		Demand
	Secondary Values >	
		Current

		Voltage
		Power
	Phasor Diagram	
	Frequency	
Inputs/Outputs >		
	Contact Inputs >	
		Board F/ Board G/ Board H/ Board J
	Cont. Output St. >	
		Board F/ Board G/ Board H/ Board J
	Cont. Output Op. >	
		Board F/ Board G/ Board H/ Board J
	Cont. Output Rs. >	
		Board F/ Board G/ Board H/ Board J
	IO Board Status	
	Virtual Inputs >	
		Virtual Inp.Latched
		Virtual Inp.SR
	Virtual Outputs	
	Remote Outputs >	
		DNA
		User St
	Remote Inputs >	
		Remote Input
		Remote Devices
	Analog Inputs >	
		Board F/ Board G/ Board H/ Board J

To enter this menu press the shuttle key when the option Actual Values is selected in main menu. A secondary level will be displayed with different sublevels as shown on Table 3–30:. Rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation will be performed the same for all the menus in Actual Values. Once the last sublevel is reached, move up and down to visualize the actual values selected.

One example of data screen for actual values is shown in Figure 3–18:.

First Line: Header of last level in actual values (Phase Current in the example)

Second Line: Data identifier (in the example PH IOC1 HIGH A, is the pickup signal for the first instantaneous overcurrent function level high for phase A).

Third line: Status of the displayed actual value.

Fourth Line: Relative position in the menu (it is the first value of 114)

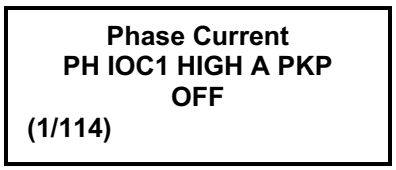


Figure 3–18: ACTUAL VALUES SCREEN DATA

In the Actual Values menus are different types of data, each type of data will display its particular status type (on and off, 0 or 1, ok or fail, analog values, etc.)

3.2.5.3 SNAPSHOT EVENTS

To enter this menu press the shuttle key when the option Snapshot events is selected in main menu (). In this menu all the snapshot events stored can be displayed.

Snapshot events are changes in the relay internal status.

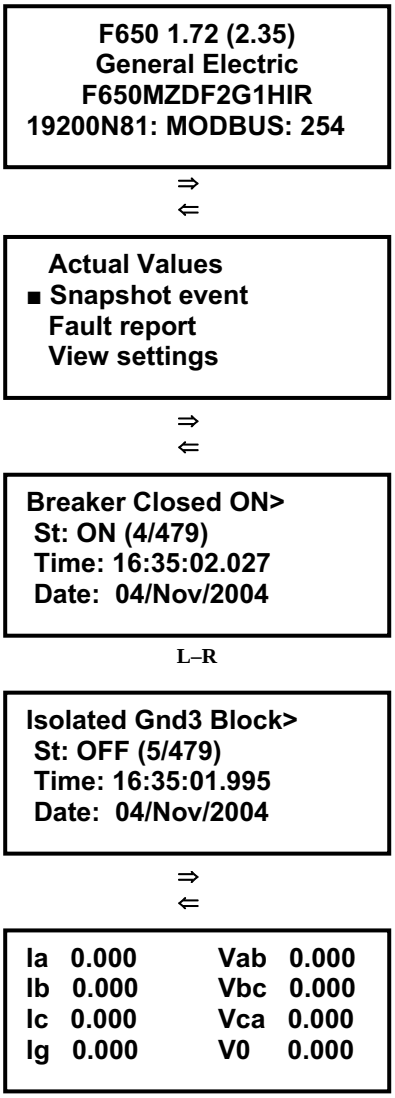
One snapshot event is displayed in two text screens:

The first screen display the status, date and time of the snapshot event: the snapshot event identifier, its status, event number and the date and time of the occurrence. If the snapshot event identifier does not fit the first line, the whole text will be shown using as well the second line alternating with the status and event number.

The second screen displays currents and voltages in primary values for that particular snapshot event. Ia, Ib, Ic and Ig for currents and Vab, Vbc, Vca and V0 for voltages. To access the metering screen in snapshot events menu, press shuttle key from the snapshot event first screen. To exit from the metering screen pres ESC.

To select different snapshot events to be displayed, rotate the shuttle key to select the snapshot event and then press the shuttle key to enter the metering screen. Press esc to exit the metering screen and return to snapshot events menu.

Figure 3–19: shows an example of snapshot events navigation:



Press shuttle key from the default main screen and enter in the main text menu.

Move the shuttle key until a single scroll bar character appears in the left part of Snapshot event header.

Press shuttle key to enter in the snapshot events menu

Select the snapshot event to display using the shuttle key (left and right to move up and down inside the recorded snapshot events).

Once selected the snapshot event, identifier , status, date and time will be displayed.

In the second line St: is showing the status and the relative snapshot index from the whole recorded number. Third and fourth lines are used to display the time and date of the snapshot event.

Pressing the shuttle key the metering screen for the snapshot event will be displayed.

To exit from this screen press the ESC key and return to the snapshot events menu.

Figure 3–19: SNAPSHOT EVENTS NAVIGATION IN HMI

3.2.5.4 FAULT REPORT

To enter this menu press the shuttle key when the option Fault report is selected in main menu (). This menu displays information about the last ten faults recorded in the relay.

The Relay HMI allows two types of visualization for the fault reports stored in the Relay:

1. Showing the fault warning messages in the text display when the fault is produced. This option has to be enabled by setting. To change from the HMI go to the menu "***Change Settings >Product Setup > Fault Report > Show Fault On HMI***" and enable it.

2.Only saving and allowing viewing the information from the last ten faults recorded in the relay.

In the first option, when a fault occurs a warning message is displayed, including information about the fault in two screens, one with general fault information, and a second one with the measured values in the moment of the fault.

The fault-warning message must be acknowledged by the user; this means that the user must press the shuttle key for this screen to disappear, The HMI will not allow to perform any other operation until the screen is acknowledged. In the event of several consecutive faults, the HMI will always show the most recent fault, and the user will need to acknowledge all of them, up to a maximum of ten faults.

In the second option, viewing the fault reports in the menu available in the HMI, the Fault Report menu in the main text screen must be accessed by pressing the shuttle key. The display will show the information about the last ten faults produced, and both the general information and the metering screens can be viewed for each fault. Displayed information starts in the most recent fault, and the user can switch to another fault by rotating the shuttle key.

Displayed information is stored in the relay volatile memory, so if the relay is turned off this information will be lost, as well as if a "Clear Fault Report" command is executed. However, fault reports stored in the relay non-volatile memory will remain after the Fault reset, and they can be obtained from the relay using EnerVista 650 Setup software, at the "Actual>Records>Fault report" menu.

If there is no fault report available through the display, the relay will show a "***Fault report not available***" message.

The format of the displayed screens is as follows:

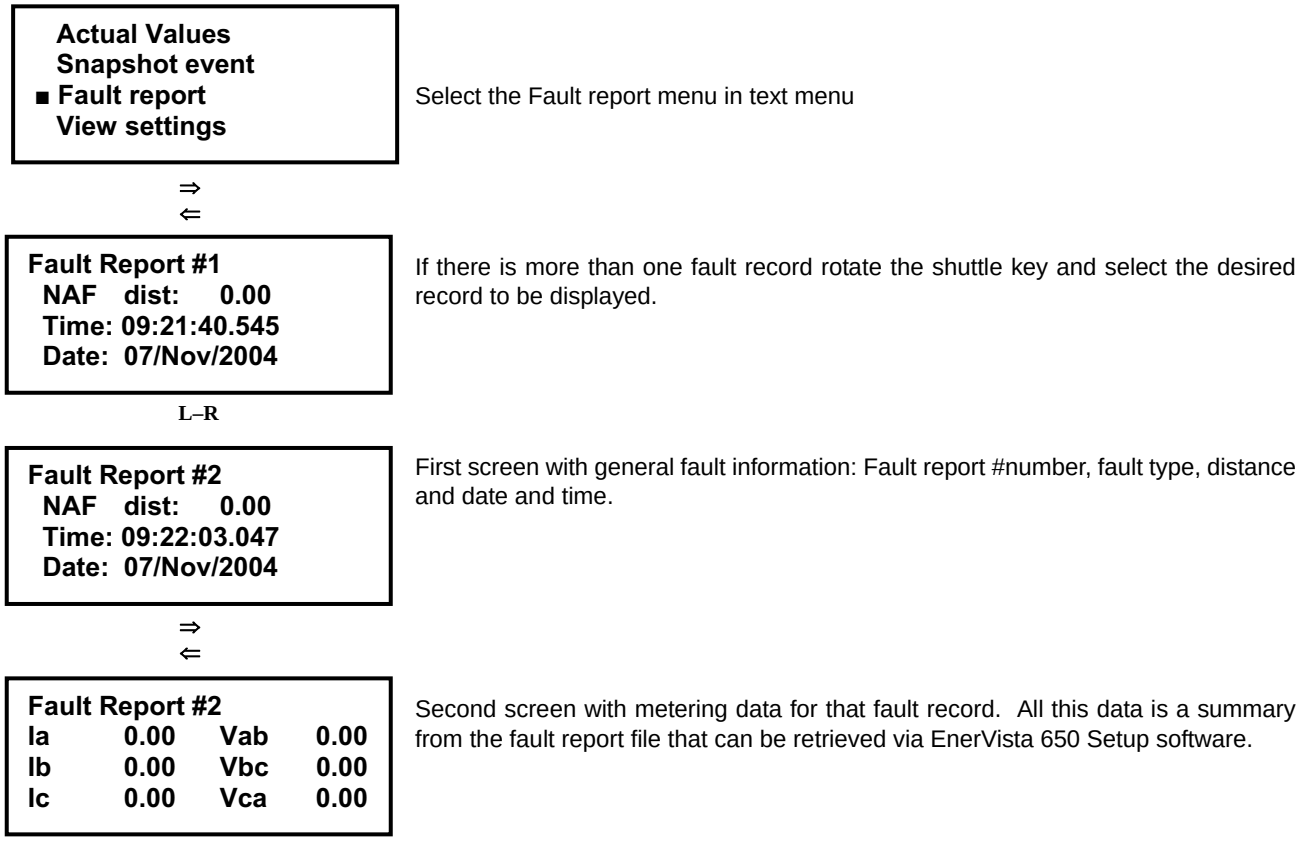

Actual Values
Snapshot event
■ Fault report
View settings
Select the Fault report menu in text menu
⇒
⇐
Fault Report #1
NAF dist: 0.00
Time: 09:21:40.545
Date: 07/Nov/2004
If there is more than one fault record rotate the shuttle key and select the desired record to be displayed.
L–R
Fault Report #2
NAF dist: 0.00
Time: 09:22:03.047
Date: 07/Nov/2004
First screen with general fault information: Fault report #number, fault type, distance and date and time.
⇒
⇐
Fault Report #2
Ia 0.00 Vab 0.00
Ib 0.00 Vbc 0.00
Ic 0.00 Vca 0.00
Second screen with metering data for that fault record. All this data is a summary from the fault report file that can be retrieved via EnerVista 650 Setup software.

Figure 3–20: FAULT REPORT NAVIGATION IN HMI

Possible fault types are as follows:

GROUND	Ground faults
	AG phase A to ground ABG phase AB to ground BG phase BG to ground BCG phase BCG to ground CG phase CG to ground CAG phase CAG to ground
PHASE	Phase to phase faults
	AB phase A to phase B BC phase B to phase C CA phase C to phase A
3PHASE	Three-phase faults (shown on the display as 3PH)
NAF	**Fault type not calculated**

3.2.5.5 VIEW SETTINGS

To enter this menu press the shuttle key when the option “View Settings” is selected in main menu. A secondary level will be displayed with different sublevels as shown on Table 3–31:.Rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the shuttle key again to enter in next level and press esc key to return to previous level if desired. This navigation will be performed the same for all the menus in “View Settings”. Once the last sublevel is reached, move up and down to visualize the settings selected.

Table 3–31: GENERAL OVERVIEW OF “VIEW/CHANGE SETTINGS” MAIN MENU

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
Product Setup >			
	Communication >		
		Serial Ports	
		Ethernet >	
			Ethernet 1
			Ethernet 2
		ModBus Protocol	
		DNP3 Slave >	
			DNP3 Slave 1
			DNP3 Slave 2
			DNP3 Slave 3
		IEC 870-5-104	
		SNTP	
	Fault Report		
	Oscillography		
	Demand		
System Setup >			
	General Settings		
	Breaker >		
		Breaker Settings	
		Breaker Maintenance	
Protection Element >			
	Phase Current >		
		Phase TOC High >	
			Phase TOC High 1
			Phase TOC High 2
			Phase TOC High 3
		Phase TOC Low >	
			Phase TOC Low 1
			Phase TOC Low 2
			Phase TOC Low 3
		Phase IOC High >	
			Phase IOC High 1
			Phase IOC High 2
			Phase IOC High 3
		Phase IOC Low >	
			Phase IOC Low 1
			Phase IOC Low 2
			Phase IOC Low 3
		Phase Directional >	
			Phase Directional 1
			Phase Directional 2
			Phase Directional 3
		Thermal Model >	
			Thermal Model 1

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
			Thermal Model 2
			Thermal Model 3
	Neutral Current >		
		Neutral TOC >	
			Neutral TOC 1
			Neutral TOC 2
			Neutral TOC 3
		Neutral IOC >	
			Neutral IOC 1
			Neutral IOC 2
			Neutral IOC 3
		Neutral Dir >	
			Neutral Dir 1
			Neutral Dir 2
			Neutral Dir 3
	Ground Current >		
		Ground TOC >	
			Ground TOC 1
			Ground TOC 2
			Ground TOC 3
		Ground IOC >	
			Ground IOC 1
			Ground IOC 2
			Ground IOC 3
		Ground Dir >	
			Ground Dir 1
			Ground Dir 2
			Ground Dir 3
	Sens. Ground Curr >		
		Sens. Ground TOC >	
			Sens. Ground TOC 1
			Sens. Ground TOC 2
			Sens. Ground TOC 3
		Sens. Ground IOC >	
			Sens. Ground IOC 1
			Sens. Ground IOC 2
			Sens. Ground IOC 3
		Isolated Gnd IOC >	
			Isolated Gnd IOC 1
			Isolated Gnd IOC 2
			Isolated Gnd IOC 3
		Sens. Ground Dir. >	
			Sens. Ground Dir. 1
			Sens. Ground Dir. 2
			Sens. Ground Dir. 3
	Neg. Seq. Current >		
		Neg. Seq. TOC >	
			Neg. Seq. TOC 1
			Neg. Seq. TOC 2
			Neg. Seq. TOC 3
	Voltage Elements >		
		Phase UV >	

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
			Phase UV 1
			Phase UV 2
			Phase UV 3
		Phase OV >	
			Phase OV 1
			Phase OV 2
			Phase OV 3
		Neutral OV High >	
			Neutral OV High 1
			Neutral OV High 2
			Neutral OV High 3
		Neutral OV Low >	
			Neutral OV Low 1
			Neutral OV Low 2
			Neutral OV Low 3
		Neg. Seq. OV >	
			Neg. Seq. OV 1
			Neg. Seq. OV 2
			Neg. Seq. OV 3
		Auxiliary OV >	
			Auxiliary OV 1
			Auxiliary OV 2
			Auxiliary OV 3
		Auxiliary UV >	
			Auxiliary UV 1
			Auxiliary UV 2
			Auxiliary UV 3
	Power >		
		Forward Power >	
			Forward Power 1
			Forward Power 2
			Forward Power 3
		Directional Power >	
			Directional Power 1
			Directional Power 2
			Directional Power 3
Control Elements >			
	Setting Group		
	Underfrequency >		
		Underfrequency 1	
		Underfrequency 2	
		Underfrequency 3	
	Overfrequency >		
		Overfrequency 1	
		Overfrequency 2	
		Overfrequency 3	
	Synchrocheck		
	Autoreclose		
	Breaker Failure		
	VT Fuse Failure		
	Broken Conductor >		
		Broken Conductor 1	

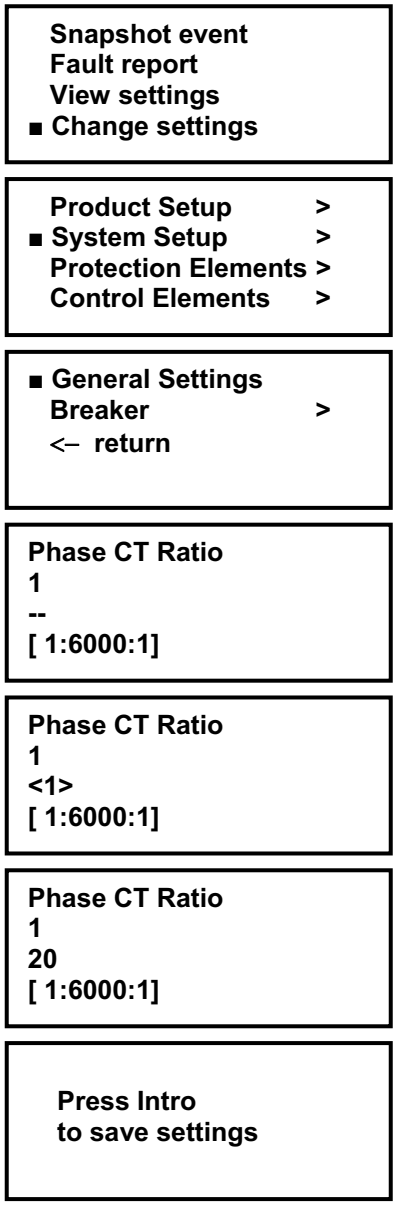
MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
		Broken Conductor 2	
		Broken Conductor 3	
	Locked Rotor >		
		Locked Rotor 1	
		Locked Rotor 2	
		Locked Rotor 3	
Inputs/outputs >			
	Remote Comms.		

3.2.5.6 CHANGE SETTINGS

To enter this menu press the shuttle key when the option “Change Settings” is selected in main menu. A secondary level will be displayed with different sublevels as shown on Table 3–31:. Rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed press the shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation will be performed the same for all the menus in “Change Settings”. Once the last sublevel is reached, move up and down to visualize the settings selected.

To change a particular setting, press the shuttle key on the setting to be modified. After selecting the setting, the value for that setting will appear between brackets. Choose the new value moving up and down the shuttle key. After selecting the appropriate value press again the shuttle key to fix that value. To save the new settings, go to the end of the menu rotating the shuttle key right, and select the menu “Press intro to save settings”. When pressing the shuttle key inside this menu the new settings will be saved.

Figure 3–21: shows an example of change settings navigation:



Select the menu Change settings and press the shuttle key to enter in the next sublevel.

If there is more than one sublevel, select the next sublevel by rotating and pressing the shuttle key till the last level is reached.

Press the shuttle key in the function to be modified

-> Group of settings

-> Setting to be modified

-> Value

-> Range and step

Pressing the shuttle key, value appears between brackets and can be modified rotating the shuttle key. Pressing again the shuttle key, the new value will be accepted.

Once all settings inside the group have been modified, go to the last screen rotating the shuttle key and press Intro. At this moment of time, the new settings will be active in the relay.

Figure 3–21: CHANGE SETTINGS PROCEDURE IN HMI

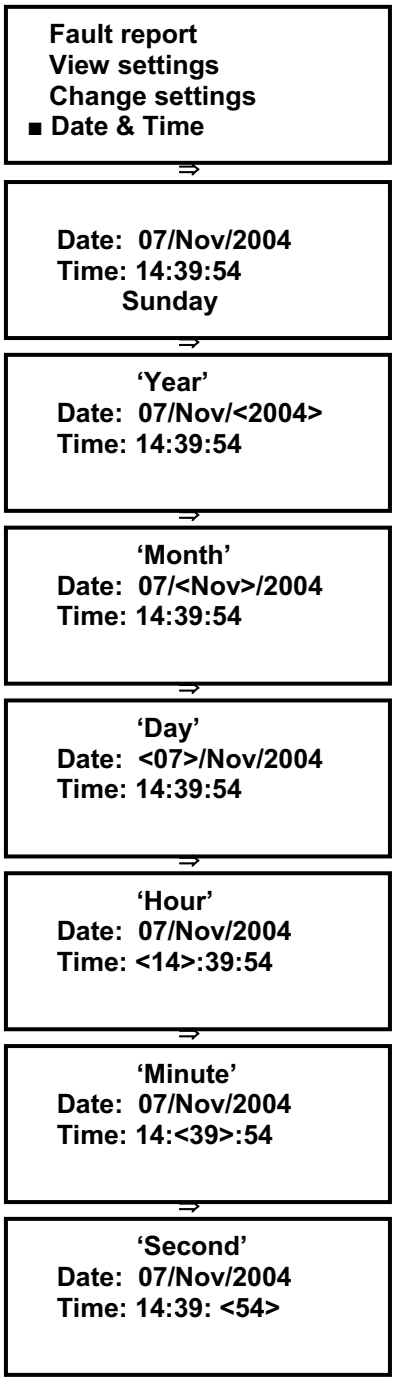
3.2.5.7 DATE & TIME

The “Date & Time” menu will show the relay date and time information in the following format:

Date:Day/Month/Year

Time:Hour:Minutes:Seconds

To modify date and time, press the shuttle key. The relay will show the year between brackets at the top of the screen. By rotating the shuttle key, reach the desired value for the year, and press the shuttle key to select and store that value. After the year, the relay will show the month. Proceed as in the case of the year. The date & time modification sequence is as follows:



Rotate the shuttle key to select the “Date and Time” menu and press to enter in it

The date and time data will appear in the format related above.

Pressing the shuttle key the year can be modified rotating the shuttle key, after selecting the desired value, press again the shuttle key to store the value.

‘Year’

Date: Day/Month/**<Year>**

Time: Hour:Minutes:Seconds

After storing the value for Year, Month will appear between brackets and can be modified

‘Month’

Date: Day/<**Month>**/Year

Time: Hour:Minutes:Seconds

After storing the value for Month, Day will appear between brackets and can be modified

‘Day’

Date: <**Day**>/Month/Year

Time: Hour:Minutes:Seconds

After storing the value for Day, Hour will appear between brackets and can be modified

‘Hour’

Date: Day/Month/Year

Time: <**Hour**>:Minutes:Seconds

After storing the value for Hour, Minutes will appear between brackets and can be modified

‘Minute’

Date: Day/Month/Year

Time: Hour:<**Minute**>:Seconds

After storing the value for Minutes, Seconds will appear between brackets and can be modified

‘Second’

Date: Day/Month/Year

Time: Hour: Minute:<**Seconds**>

Once this sequence is completed, these values will remain stored in the relay, and the display will show again the date at the bottom of the text screen.

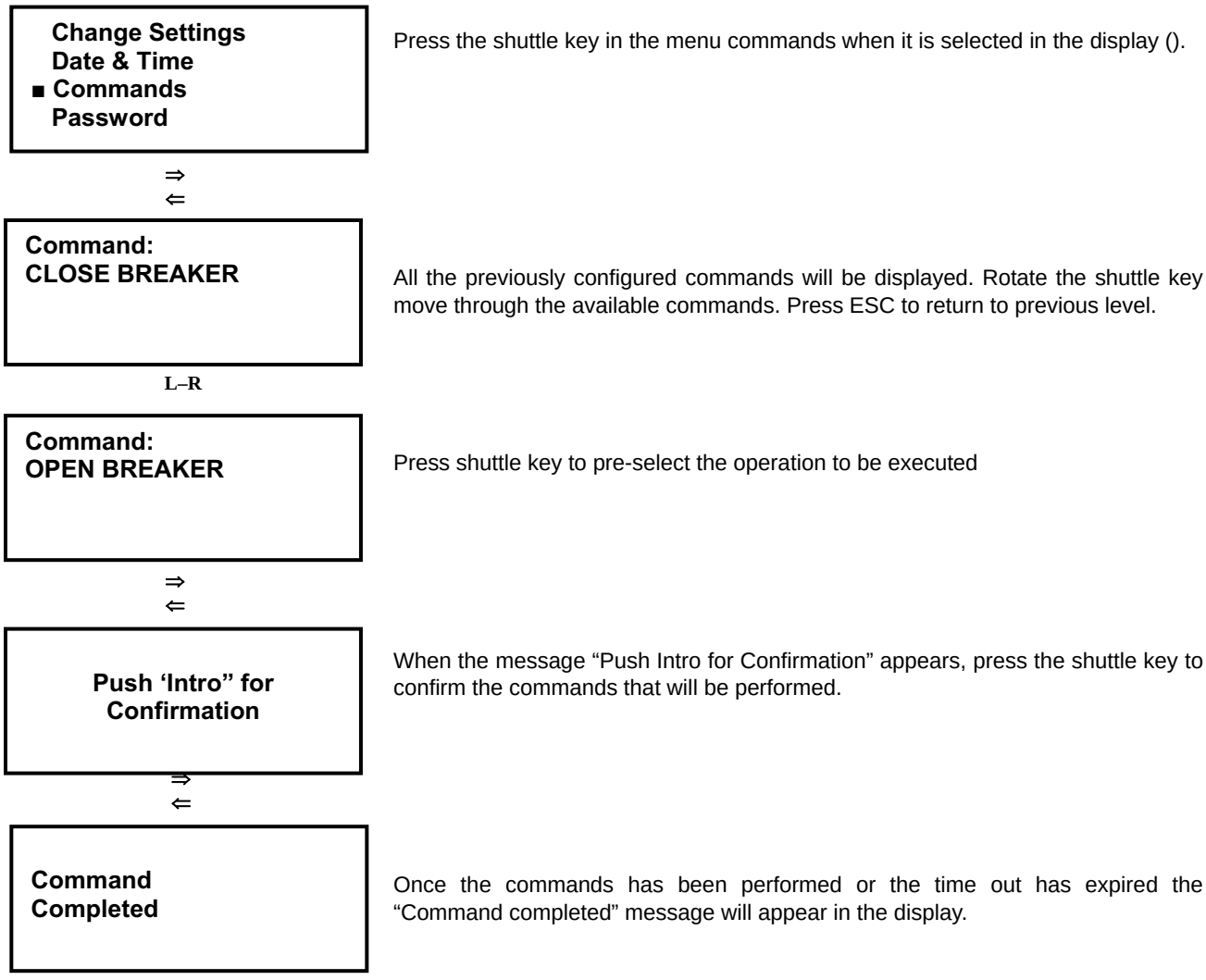
Figure 3–22: CHANGE DATE AND TIME PROCEDURE IN HMI

3.2.5.8 COMMANDS

Commands are configured using EnerVista 650 Setup, and they can be executed using the pushbuttons on the relay front.

Using EnerVista 650 Setup software, the user can configure up to 24 commands with a descriptive text. When executing the operation from the relay front, the operation description text will be displayed.

Example of commands (operations) executions via HMI



Press the shuttle key in the menu commands when it is selected in the display ().

All the previously configured commands will be displayed. Rotate the shuttle key move through the available commands. Press ESC to return to previous level.

Press shuttle key to pre-select the operation to be executed

When the message "Push Intro for Confirmation" appears, press the shuttle key to confirm the commands that will be performed.

Once the commands has been performed or the time out has expired the "Command completed" message will appear in the display.

Figure 3–23: COMMANDS IN HMI

3.2.5.9 PASSWORDS

F650 units incorporate independent passwords for protection and control, in order to prevent unauthorized keypad and display access to the relay.

Settings Password:

This password allows restricting access to settings changes in the relay protection elements.

Commands Password:

This password is required for executing operation commands through the keypad and display.

If the Commands Password is activated, when the user tries to execute an operation, the relay will request this password, and in case of using the single-line diagram for graphical display models, all objects will not be operational until this password is entered, either logging in ***Login Pwd Commands***, or entering the password in the ***Commands*** menu.

Relay settings view, measures, and other monitored information are not password-protected, and they can be accessed by all users.

Access to the password menu is located at the ***Password*** option in the relay text menu. This menu includes the following options:

"Login Pwd Settings"

"Logout Pwd Settings"

"Change Pwd Settings"

"Login Pwd Commands"

"Logout Pwd Commands"

"Change Pwd Commands"

"Forgot Password?"

Among the available options in this menu, there are three types of functionality:

Login: For entering the password, either for settings or commands, and enable access to settings or commands. Once entering the password the relay is no longer password protected, and access is enabled to settings modification or commands execution.

Logout: Once the necessary setting changes or operation commands have been executed, the user can log out, so that the relay is password protected again.

Change: This menu allows setting or modifying the desired password.

Forgot Password: This menu provides the encrypted password, so that it can be recovered if the user loses or forgets it.

Passwords are restricted for Settings change and Commands execution. To password-protect the relay, it is first necessary to set the desired password, using the corresponding “Change Pwd ...” menu. The default password is **0000**. This password provides access to the whole relay functionality.

Once a new password has been set, the user must log in to access the protected functionality; otherwise, the relay will request the password when trying to change settings or execute commands. Once the password is entered the relay is unprotected (as if the user had logged in), and the user must log out to protect again the relay.

a) PASSWORD RANGE

The valid range for F650 passwords is a number from 0000 to 9999.

The default password is 0000, which provides access to the whole relay functionality. This is the default option for enabling relay use without using passwords.

b) ENTERING THE PASSWORD (LOGIN PWD)

This operation is the same for both the settings and commands passwords. The only difference will be the access menu. For entering the password, the user must access the ***Login*** menus inside the ***Password*** menu.

Login Pwd Settings or *Login Pwd Commands:*

The relay requests the password with the following message on the screen:

Setting passwd.

Login: < 1000 >

For entering the desired password, the user must rotate the shuttle key to the left (decrease) or to the right (increase), and establish the desired number. Once entered, the selected password between brackets has been entered, the relay will show the message **"Processing passwd. Wait..."**. If the password is correct, the relay will allow access to the settings change or command execution. It is not necessary to enter the password every time a change is to be performed. The relay will request the password 15 minutes after the last keypad action has taken place. This period of time is the same that takes the relay to turn off the display backlighting.

c) LOGGING OUT (LOGOUT PWD)

To disable access to settings and commands, the user must logout.

Logout Pwd Settings or *Logout Pwd Commands:*

For safety reasons, if the user does not log out, the relay will do it automatically 15 minutes after the last keypad action.

d) CHANGING THE PASSWORD (CHANGE PWD COMMANDS)

To set a password in the relay, both for settings and commands, the corresponding menu must be accessed inside the ***Password*** menu:

Change Pwd Settings or *Change Pwd Commands:*

To modify the password, the user must first introduce the existing password; if the relay has the default factory password, this would be 0000.

For modifying the password, the relay requests the existing password with the following message:

(Setting or Command) passwd.

Login: < 0000 >

Once the entered password has been acknowledged, the new password must be entered:

(Setting o Command) passwd.

New passwd: < 1000 >

Once the new password has been entered, the relay returns to the general Passwords menu.

e) PASSWORD RECOVERY (FORGOT PASSWORD?)

If the relay passwords need to be recovered, the ***"Forgot Password?"*** menu must be accessed. This menu is the last option inside the text ***Passwords*** menu.

This menu will show two passwords, which correspond to the encrypted protection settings, and commands passwords, as shown in the following example:

Cod Settings: [35c0]

Cod Commands: [35c0]

<Push Intro>

In order to obtain the decoded password from the encrypted codes provided by the relay, it is necessary to contact GE Multilin and provide these encrypted codes.

3.2.5.10 SELECT MAIN SCREEN

The relay display offers the possibility to select the default main screen. For this purpose, the user must access the "***Select Main Screen***" menu through the HMI. This menu includes the following options:

Logotype

This option selects as main screen the relay logotype including the firmware and boot code versions, the relay model and the communication parameters for local port COM2.

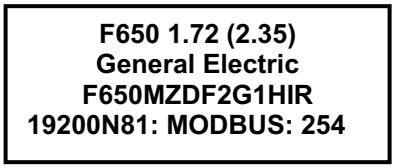


Figure 3–24: DEFAULT LOGOTYPE SCREEN

Metering

This option shows a Metering screen including the phase and ground currents as well as phase-to-phase voltage, and zero sequence voltage values, all of them in primary values.

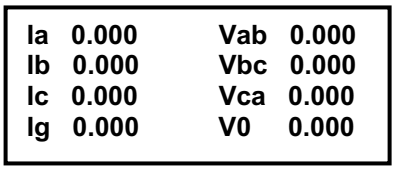


Figure 3–25: DEFAULT METERING SCREEN

All

This option alternates in time the two previous options.

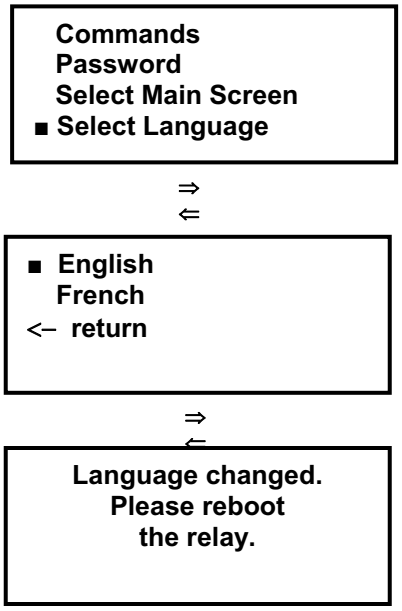
3.2.5.11 SELECT LANGUAGE

Option only available for versions 1.70 or higher.

The relay display offers the possibility to select the default language for the relay. For this purpose, the user must access the "***Select language***" menu located at the end of the main menu through the HMI. This menu allows the user to set the default language of the relay between English (always available) and second language selected in the relay model. (see section 2.3 ORDERING CODE).

For example one relay in French language (e.g. F650MZDF2G1HIR**F**) can be displayed in French or in English only by changing the language setting in HMI. It is necessary to switch off and on the relay to start working with the new language configuration in the relay. In EnerVista 650 Setup it is possible to select the language for the software (View>Languages).

Example of language selection in HMI



Press the shuttle key to enter the select language menu.

Depending on the relay model there will be available different kind of language selections: English/French, English/ Russian, etc.

Rotate the shuttle key to select the desired language and press it to store the selection in the relay

Once the new language has been selected it is necessary to reboot the relay in order to start working with the new language in the device.

Figure 3–26: LANGUAGE SELECTION IN HMI

3.2.6.1 ONE-LINE DIAGRAM

In models with graphic display (F650M) default main screen is the single-line diagram. This single-line diagram can be configured using EnerVista 650 Setup software by choosing the ***HMI*** menu inside ***Relay Configuration*** (***Settings>Relay Configuration>HMI***).

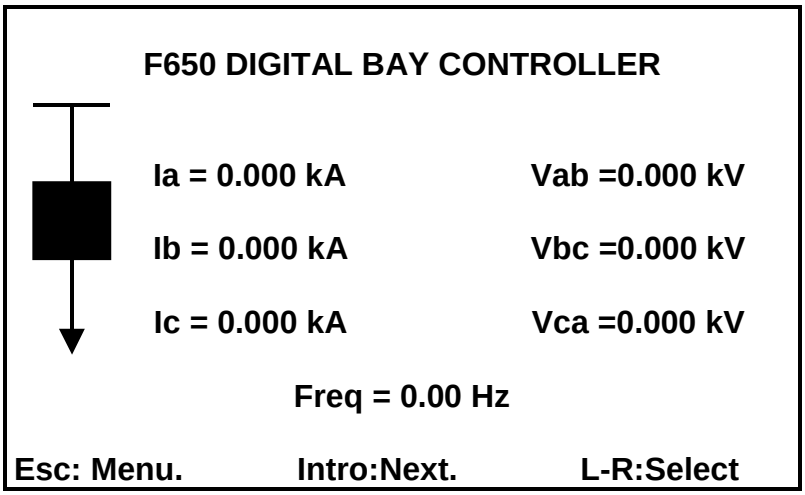


Figure 3–27: ONE-LINE DIAGRAM

The bottom of the display shows a legend that indicates the possible selections that can be made from this screen.

Esc: Menu.Intro: Next.L-R: Select.

The meaning of these options is as follows:

Esc: Menu.

Pressing the ESC key, the user will access the relay main menu, similar to the one displayed by the text-display model (F650B).

Pressing again the ESC key; the menu selection screen (Actual Values, Snapshot events, etc.) will be displayed. This main menu screen is identical to the one described for the text display. Its functionality is described in section 3.2.5 in this manual.

Intro: Next.

Pressing the shuttle key, the user access the next graphical screen, which in this case corresponds to the primary metering values screen.

L-R: Select

Once the different switchgear elements to be operated have been configured using EnerVista 650 Setup, the user will be able to operate them from the graphic display.

If a single-line diagram has been previously configured in the EnerVista 650 Setup, in the HMI option inside the ***Relay Configuration*** menu, the different switchgear elements configured for the display will be operative from the graphic display. By rotating the shuttle key to the left and right, the cursor moves among the elements and blinks on each of them. When an element is selected by pressing the shuttle key, the relay will indicate the command to be executed, and the user will need to confirm it by pressing again the shuttle key.

The following sections describe only the operation of screens that are specific for the graphic display models.

3.2.6.2 METERING SCREEN

The Metering screen displays relay analog measures in their primary values. Available metering values are as follows:

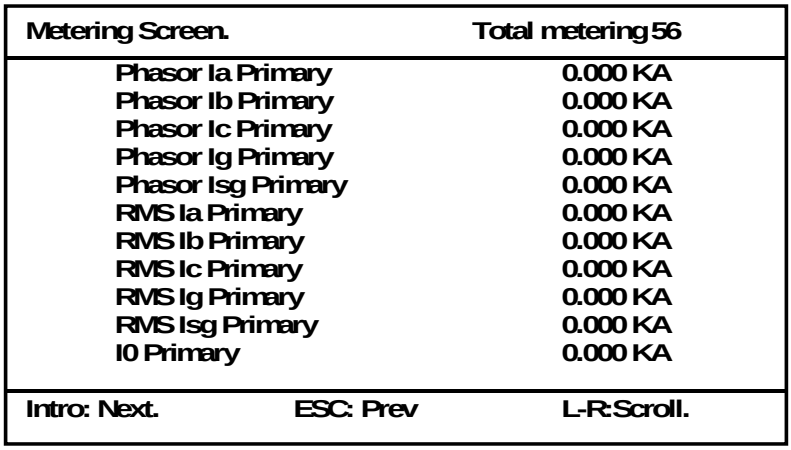

Metering Screen. Total metering 56
Phasor Ia Primary 0.000 KA
Phasor Ib Primary 0.000 KA
Phasor Ic Primary 0.000 KA
Phasor Ig Primary 0.000 KA
Phasor Isg Primary 0.000 KA
RMS Ia Primary 0.000 KA
RMS Ib Primary 0.000 KA
RMS Ic Primary 0.000 KA
RMS Ig Primary 0.000 KA
RMS Isg Primary 0.000 KA
I0 Primary 0.000 KA
Intro: Next. ESC: Prev L-R:Scroll.

Figure 3–28: METERING SCREEN

As in the rest of graphical display screens, the bottom part shows a legend that indicates the possible options for the user. In this case, the options are:

Intro: Next.Esc: Prev.L-R: Scroll.

Intro: Next.

Pressing the shuttle key the user accesses the next screen, in this case the ALL EVENTS screen.

Esc: Prev.

Pressing the ESC key the user returns to the previous screen (One-line diagram)

L-R: Scroll.

Rotating the shuttle key to the left (L) or right (R) the user can access all the Metering values in the screen. Rotating the shuttle key left will move up in the screen, and rotating right will move down.

METERING SCREEN ANALOG MEASURES IN PRIMARY VALUES			
Phasor Ia Primary	V0 Primary	Phase A Real Pwr	Line Frequency Primary
Phasor Ib Primary	V1 Primary	Phase B Reactive Pwr	Bus Frequency Primary
Phasor Ic Primary	V2 Primary	Phase B Apparent Pwr	Vx Primary
Phasor Ig Primary	Vab Primary	Phase B Real Pwr	Positive MVarhour
Phasor Isg Primary	Vbc Primary	Phase C Reactive Pwr	Negative MVarhour
Phasor In Primary	Vca Primary	Phase C Apparent Pwr	Positive MWatthour
RMS Ia Primary	Vn Primary	Phase C Real Pwr	Negative MWatthour
RMS Ib Primary	Va Primary	3 Phase Reactive Pwr	Pos MVarhour Cnt
RMS Ic Primary	Vb Primary	3 Phase Apparent Pwr	Neg MVarhour Cnt
RMS Ig Primary	Vc Primary	3 Phase Real Pwr	Pos MWatthour Cnt
RMS Isg Primary	VBB Primary	Phase A Power Factor	Neg MWatthour Cnt
I0 Primary	VL Primary	Phase B Power Factor	
I1 Primary	Phase A Reactive Pwr	Phase C Power Factor	
I2 Primary	Phase A Apparent Pwr	3 Phase Power Factor	

3.2.6.3 ALL EVENTS SCREEN

This screen shows all events that have been produced in the relay. The top of the screen shows its name (All Events), and the relative and total number of events contained in the screen.

All Events (1/479)

This legend means that there are a total of 479 events stored in the relay, and that the cursor is located on event number 1. The information shown on this screen for each event is as follows:

"**Hour:Minute:Second:Millisecond" "Event text" "Event status(ON/OFF)"**

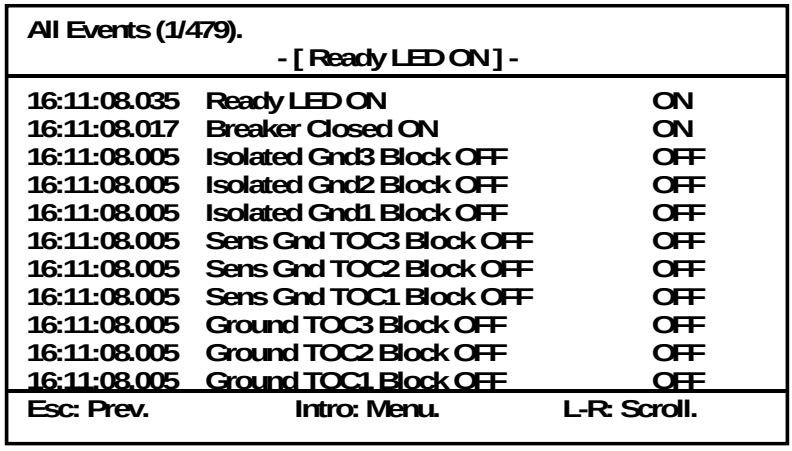

All Events (1/479).
- [Ready LED ON] -
16:11:08.035 Ready LED ON ON
16:11:08.017 Breaker Closed ON ON
16:11:08.005 Isolated Gnd3 Block OFF OFF
16:11:08.005 Isolated Gnd2 Block OFF OFF
16:11:08.005 Isolated Gnd1 Block OFF OFF
16:11:08.005 Sens Gnd TOC3 Block OFF OFF
16:11:08.005 Sens Gnd TOC2 Block OFF OFF
16:11:08.005 Sens Gnd TOC1 Block OFF OFF
16:11:08.005 Ground TOC3 Block OFF OFF
16:11:08.005 Ground TOC2 Block OFF OFF
16:11:08.005 Ground TOC1 Block OFF OFF
Esc: Prev.
Intro: Menu.
L-R: Scroll.

Figure 3–29: ALL EVENTS SCREEN

The screen legend options are:

Esc: Prev. Intro: Menu. L-R: Scroll.

Esc: Prev.

Pressing the ESC key, the user returns to the previous screen (Metering screen)

Intro: Menu.

Pressing the shuttle key, the user accesses the Events menu that offers the following options at the bottom of the screen:

next prev reload details At

To access the different options in the snapshot events graphic menu the user must move the cursor from left to right. The selected option will be displayed in upper case and between brackets. To access the selected option, the user must press again the shuttle key.

<NEXT>

The user accesses the next available graphic screen (Events – New)

<PREV>

This option returns to the general events graphic menu (All Events)

<RELOAD>

This option updates all events stored in the relay and returns to the general events screen.

<DETAILS>

The Details screen provides access to metering values, and date and time related with the event.

The top of the screen displays a legend with the event text, followed by the date and time, the event status (ON or OFF), and the event index number related to the complete list of events in the relay, for example (1/479). The rest of information provided by the Details screen corresponds to the relay measures in the moment of the event. Metering values provided in the events are secondary, and voltage values correspond to phase-to-ground voltage.

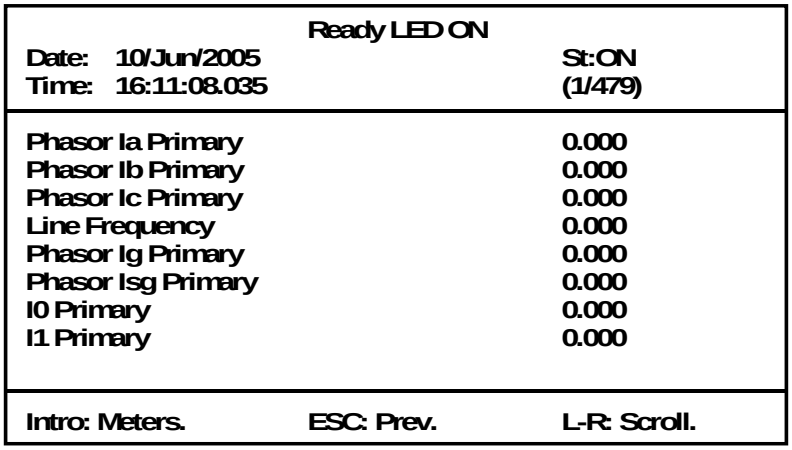


Figure 3–30: SNAPSHOT EVENTS DETAIL SCREEN

To navigate this screen the user must follow the legend at the bottom of the screen:

Intro: Meters. ESC: Prev.L-R: Scroll.

Intro: Meters.

To access the metering values in the moment of the event, the user must press the shuttle key. A new metering screen will be displayed, containing the primary metering values in the snapshot event, such as:

Phasor Ia Primary	I2 Primary
Phasor Ib Primary	Vab Primary
Phasor Ic Primary	Vbc Primary
Line Frequency Primary	Vca Primary
Phasor Ig Primary	V1 Primary
Phasor Isg Primary	V2 Primary
I0 Primary	V0 Primary
I1 Primary	3 Phase Power Factor

Once inside the Metering screen, a new legend will be shown for each event (Intro or ESC: Prev. L-R: Scroll); this legend indicates that by pressing ESC or the shuttle key, the system will return to the Event Detail screen, and rotating the shuttle key the user will access all the metering values contained in the metering screen of the considered event.

ESC: Prev.

If the user presses the ESC key from the event detail screen, the system will return to the all events screen.

L-R: Scroll.

Rotating the shuttle key left (L) or right (R) moves among all the events contained in the all events screen, allowing a preview of the details for each of them.

<AT>

When this option is selected, the system marks the event where the cursor is located. A relative time stamp is performed, in such a way that the selected event, marked with an asterisk (*) between the time and the event name is set with a relative time of 00:00:00:000 on the top line of the event screen, together with its relative index, and the rest of events in the screen will show a date/time that relates to the marked event. This operation mode allows a quick inspection of the relative time passed between several events, which is very useful for analyzing events in the field. The corresponding legend to this relative event-marking screen is as follows:

Esc: Out At. **Intro: Tag event.**

Esc: Out At.

The relative event marking is eliminated and the system returns to the general events screen.

Intro: Tag event.

If the user places the cursor on a different event by rotating the shuttle key left or right, pressing the shuttle key will change the relative mark to that new event.

3.2.6.4 NEW EVENTS SCREEN

This screen shows the new events that have been produced in the relay since the last time the New Events screen was read. The top of the screen shows a "**New Events**" legend, and the relative and total number of events contained.

Navigation through the different menus in this New Events screen is similar to the one described in the previous section for All Events. The main difference is that in the case of new events it is necessary to select the ***RELOAD*** submenu to update the screen with new events that have been produced, while in the All Events screen, this refreshment is automatic.

After the new events have been read, if the user selects again the ***Reload*** menu, the system will show a ***<No new events available.>*** message, indicating that there are no more new events available since the last reading.

3.2.6.5 ALARMS PANEL

Alarms panel can be viewed in all F650 models using communication software EnerVista 650 Setup, however, only models with graphic display allow access to the alarms panel from the HMI.

First line shows the relative and total number of alarms existing in that screen. The relative number refers to the alarm on which the cursor is located, and the total number refers to the total amount of alarms available. The second line on this screen shows an index that indicates the number of the configured control event that corresponds to the displayed alarm, followed by the alarm text configured in the ***Control Events*** menu inside the ***Relay Configuration*** option ("***Settings>Relay Configuration>Control Events***").

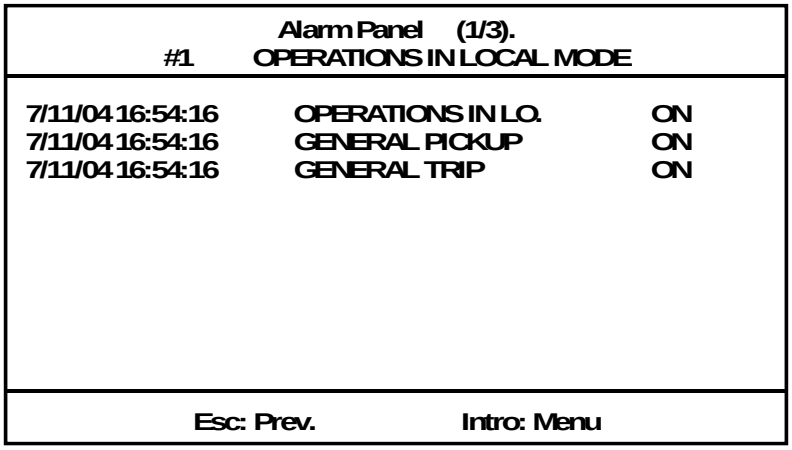

Alarm Panel (1/3).
#1 OPERATIONS IN LOCAL MODE
7/11/04 16:54:16 OPERATIONS IN LO. ON
7/11/04 16:54:16 GENERAL PICKUP ON
7/11/04 16:54:16 GENERAL TRIP ON
Esc: Prev. Intro: Menu

Figure 3–31: ALARMS PANEL IN HMI

The rest of the screen shows the different alarms produced in the relay with the date and time when the corresponding event was produced, followed by the alarm identification text, and its status, active (ON) or inactive (OFF).

In the previous example, the produced alarm is the change to local of the execution of operations (OPERATIONS IN LOCAL MODE), the date and time when this event has been produced, and its status (ON):

The bottom of the screen shows the legend that indicates how to navigate through the different options available in the screen.

ESC: Prev. Intro: Menu.

ESC: Prev.

Pressing the ESC key, the system returns to the previous New Events screen.

Intro: Menu.

Pressing the shuttle key, the user accessed the available alarms menu, which includes the following options.

next prev ack ack all

To access the different options provided by the alarms graphic menu, the user must move the shuttle key left to right. The selected option will be displayed in upper case and between brackets. To access the selected option, the shuttle key must be pressed.

<NEXT>

This option provides access to the next available graphic screen (I/O boards)

<PREV>

The system returns to the previous New Events screen.

<ACK>

This option acknowledges the alarm on which the cursor is located.

<ACK ALL>

This option acknowledges all alarms. Alarm acknowledgement through the graphic HMI is considered as through communication port COM2, as it is considered to be Local in both cases.

When an alarm has been acknowledged, a selection mark will appear to the right of its status. Inactive alarms will disappear from the screen once they are acknowledged.

3.2.6.6 INPUT/OUTPUT MONITORING SCREEN

This is the last screen available in the graphic display. This screen allows viewing the status of the relay inputs and outputs, as well as emulate inputs (for verification of the logic, or related functions), and contact outputs (to verify wiring).

The format of this screen is shown on the figure below.

The first line shows the name of the screen “I/O Cards”, followed by the type and description of the board where the cursor is located, which will appear between selection marks **> <** and blinking.

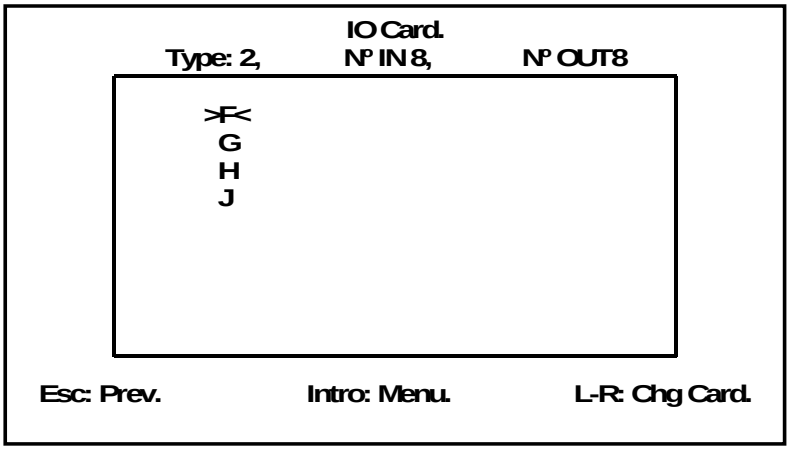


Figure 3–32: INPUTS/OUTPUTS GENERAL SCREEN

The navigation legend on this screen is as follows:

Esc: Prev.Intro: Menu.L-R: Chg Card

Esc: Prev.

This option returns to the previous screen (Alarms Panel).

Intro: Menu.

This option provides access to the selected I/O board menu:

This menu includes the following options.

next view test input test output

As in previous screens, to access the different options provided by the inputs/outputs graphic menu, the user must move the shuttle key left to right. The selected option will be displayed in upper case and between brackets. To access the selected option, the shuttle key must be pressed.

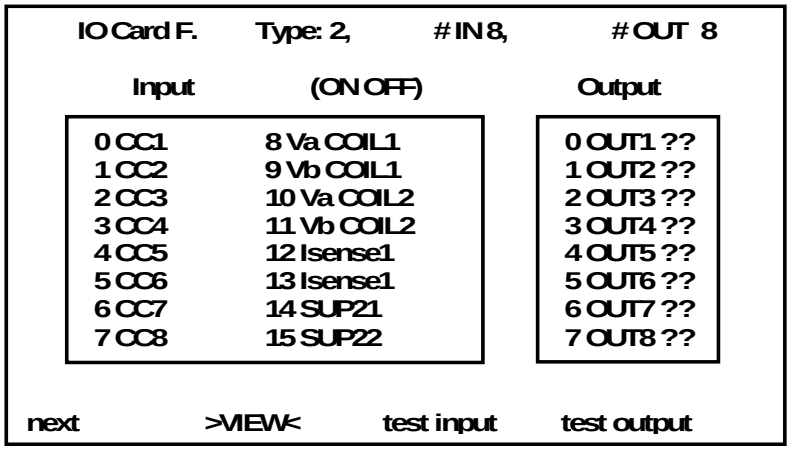


Figure 3–33: INPUT/OUTPUT VIEWING SCREEN

<NEXT>

This option brings the system back to the one-line diagram.

<VIEW>

This option shows the real status of all inputs and outputs in the selected board. Depending on the type of board, with or without supervision, the screen will vary to get adapted to the characteristics of each board.

The first line of this screen shows the slot where the board is located, **F**, **G**, **H** or **J**, and the type of board, **2** if it includes supervision (8 inputs, 8 outputs, and 4 supervision circuits), or **1** if it is a mixed board (without supervision) with 16 digital inputs and 8 outputs. The view menu differentiates inputs and outputs; the active status (ON) is represented by the lighting of the corresponding input or output.

The legend at the bottom of the screen indicates how to navigate:

Esc: Prev. **Intro: Menu.** **L-R: Chg Card**

Esc: Prev.

Returns to the general I/O screen

Intro: Menu.

Provides access to the I/O menu (next, view, test input, test output).

L-R: Chg Card

Moving the shuttle key to the left or right provides access to the status of inputs/outputs for the different boards available in the relay.

<TEST INPUT>

This option allows testing the input activation (in emulation mode). The displayed screen is similar to the viewing screen, but in this case the user can operate the different relay inputs.

This screen shows the ***Input*** name lit up, showing that this is an Input emulation mode.

The first relay input will appear blinking and between brackets; the user can select a different input by rotating the shuttle key. When the shuttle key is pressed, the selected input will be activated. Navigation through this screen is indicated by the following legend:

Esc: Exit Text. **Intro: Chg Input.**

Esc: Exit Text.

The ESC option returns to the general I/O board menu.

Intro: Chg Input.

Pressing the shuttle key on the blinking input, this input will be activated in emulation mode.

Note: input emulation can only be executed through the TEST INPUT tool on the graphic display.

<TEST OUTPUT>

This option allows testing the output activation in emulation mode. The displayed screen is similar to the viewing screen, but in this case the user can operate the different relay contact outputs to test the wiring.

This screen shows the ***Output*** name lit up, showing that this is an output emulation mode.

The first relay output will appear blinking and between brackets; the user can select a different output by rotating the shuttle key. When the shuttle key is pressed, the selected output will be activated. Navigation through this screen is indicated by the following legend:

Esc: Exit Text. **Intro: Chg Output.**

Esc: Exit Text.

The ESC option returns to the general I/O board menu.

Intro: Chg Output.

Pressing the shuttle keyshuttle key on the blinking output, this output will be activated in emulation mode.

Note: Output emulation can be executed through the TEST OUTPUT tool on the graphic display, and also through communications using EnerVista 650 Setup software for all F650 models.

L-R: Chg Card

Rotating the shuttle key allows to change the selected I/O board in the main I/O screen.

3.3.1 HOME

The web server in the F650 can be accessed running the Windows explorer, and keying http://xxx.xxx.xx.xxx, being xxx.xxx.xxx.xxx the relay IP address, which must be configured in ***Setpoint > Product Setup > Communication Settings > Ethernet*** .

The main screen of the F650 web server shows the different monitoring possibilities for snapshot events, events, alarms, oscillography, fault reports, data logger and metering values provided by the relay through the web.

In order to access the different functions provided by the web server, the user must simply click on the list name on the left side of the screen.

The web server (for version 1.70 and higher ones) allows the user to visualize the different web server screen languages: English, French, Spanish and Russian by pressing the language button on the top right corner of the main window. Take into account that this selection only changes the language in the web server screen, all the relay texts, such as snapshot events, control events, etc. will be the in the language selected in the relay (see section 3.2.5.11 in this manual).

Figure 3–34: WEB SERVER MAIN SCREEN

3.3.2 SNAPSHOT EVENTS

The Snapshot events screen shows all Snapshot events produced in the relay. This screen is refreshed automatically every minute.

The information provided in this screen includes: first, the relative event index, the lowest index corresponding to the most recent event; next, the event text that shows the reason for the event, its status, active (ON) or inactive (OFF), and finally the date and time when the event was produced.

The bottom of the screen shows a Metering screen; clicking on one of the events, the associated metering values will be shown on that screen.

Archivo Edición Ver Favoritos Herramientas Ayuda
Atrás Búsqueda Favoritos Historial
http://192.168.37.126/SnapShotEvents.htm
Ir a Vínculos SnagIt
GE Multilin
ENGLISH
FRANçAISE
ESPAÑOL
GE HOME
HOME
SNAPSHOT EVENTS
CONTROL EVENTS
ALARMS
OSCILLOGRAPHY
FAULT REPORT
DATA LOGGER
METERING
1 Breaker Closed ON ON Date: 07/11/2004 Time: 17:10:17.796
2 Breaker Open OFF OFF Date: 07/11/2004 Time: 17:10:17.796
3 Breaker Closed OFF OFF Date: 07/11/2004 Time: 17:10:16.615
4 Breaker Open ON ON Date: 07/11/2004 Time: 17:10:16.615
5 Phase UV1 AB OP ON Date: 07/11/2004 Time: 16:54:57.487
6 GENERAL TRIP ON Date: 07/11/2004 Time: 16:54:57.458
7 Oscillo Trigger ON ON Date: 07/11/2004 Time: 16:54:57.458
8 Osc Digital Channel 4 ON ON Date: 07/11/2004 Time: 16:54:57.458
9 Osc Digital Channel 1 ON ON Date: 07/11/2004 Time: 16:54:57.458
10 Fault Locator Trigger ON ON Date: 07/11/2004 Time: 16:54:57.458
11 AR Initiate ON ON Date: 07/11/2004 Time: 16:54:57.458
12 Phase UV1 OP ON Date: 07/11/2004 Time: 16:54:57.458
13 Phase UV1 CA OP ON Date: 07/11/2004 Time: 16:54:57.458
14 Phase UV1 BC OP ON Date: 07/11/2004 Time: 16:54:57.458
15 GENERAL PICKUP ON Date: 07/11/2004 Time: 16:54:47.458
16 Osc Digital Channel 9 ON ON Date: 07/11/2004 Time: 16:54:47.458
17 Osc Digital Channel 6 ON ON Date: 07/11/2004 Time: 16:54:47.458
18 Phase UV1 PKP ON Date: 07/11/2004 Time: 16:54:47.458
19 Phase UV1 CA PKP ON Date: 07/11/2004 Time: 16:54:47.458
Metering: 1 Breaker Closed ON ON Date: 07/11/2004 Time: 17:10:17.796
Phasor Ia Primary : 0.000
Phasor Ib Primary : 0.000
Phasor Ic Primary : 0.000
Line Frequency : 0.000
Phasor Ig Primary : 0.000
F650
Listo
Internet

Figure 3–35: SNAPSHOT EVENTS SCREEN

3.3.3 CONTROL EVENTS

The control events screen provides access to all events that have been configured in the Control Events screen inside the ***Relay Configuration*** menu of EnerVista 650 Setup.

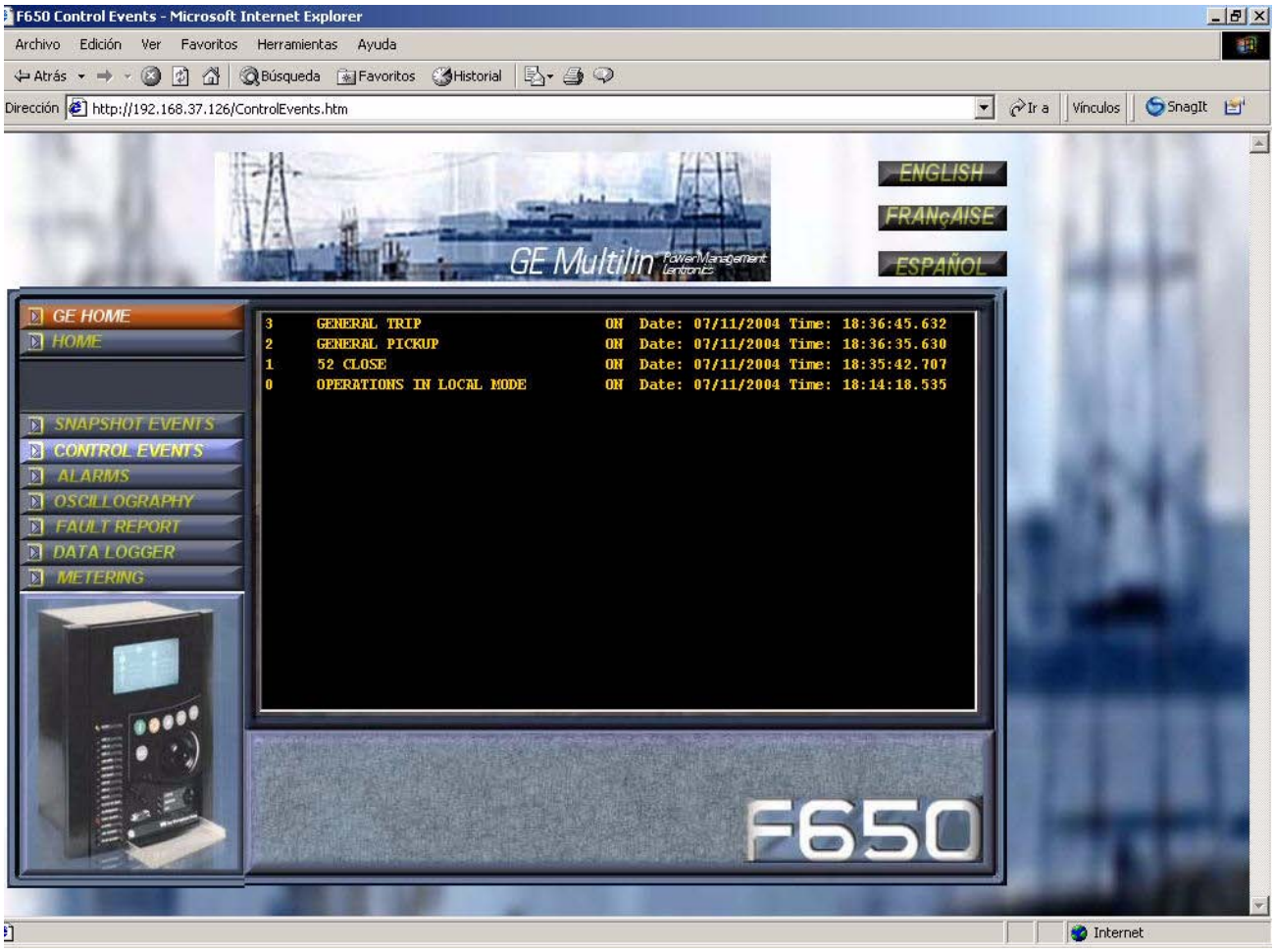


Figure 3–36: CONTROL EVENTS SCREEN

Unlike the case of Snapshot events, in this screen the highest index corresponds to the most recent event. The information provided is the control event index, the text that has been associated to such event when configured, its status, active (ON) or inactive (OFF), and its date and time.

3.3.4 ALARMS

The alarms screen provides access to alarms configured in the relay. As in the case of snapshot events and control events, this screen allows only to view the alarms, but not to acknowledge them.

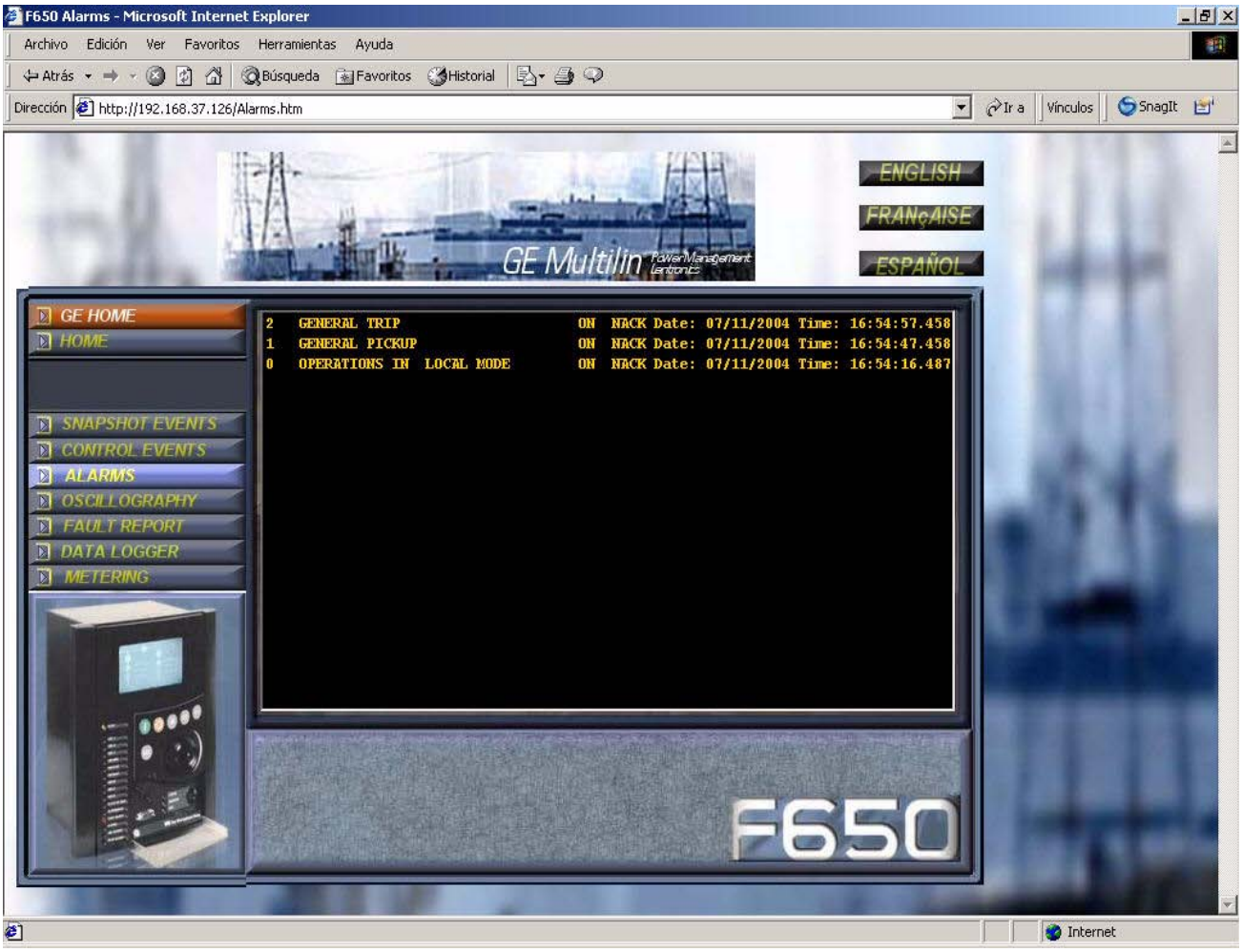


Figure 3–37: ALARMS SCREEN

The oscillography screen allows obtaining from the relay available oscillography records in that moment.

This screen includes two windows. The first window shows oscillography records available in the relay, identified by an index, being the highest index the most recent record (oscillography record No 6 in the example below).

Figure 3–38: OSCILLOGRAPHY SCREEN

If the user clicks on the oscillo record he wants to retrieve, the window on the right will show a description of the record header, indicating its date, time, and the most relevant parameters of the record. Once a record is selected, it is required to press the ***Download*** button. The system will then open a window to allow saving the files in Comtrade format in the PC hard drive. Once the records have been saved, the system will ask if the user wants to open GE-OSC tool (Comtrade record viewer) to view the downloaded files.

Figure 3–39: GE-OSC LAUNCH SCREEN

Clicking on the *Home* option, the system will return to the web server main screen.

3.3.6 FAULT REPORT

The fault report screen provides access to the last 10 fault reports obtained by the relay. These records are stored according to an index that marks their position among all records produced in the relay, with a range from 1 to 999, returning to 1 in case of exceeding the limit of 999. As in the case of oscillography records, the highest index corresponds to the most recent record.

In the fault report, oscillography and data logger screens, the system will request acceptance of a safety-warning message.

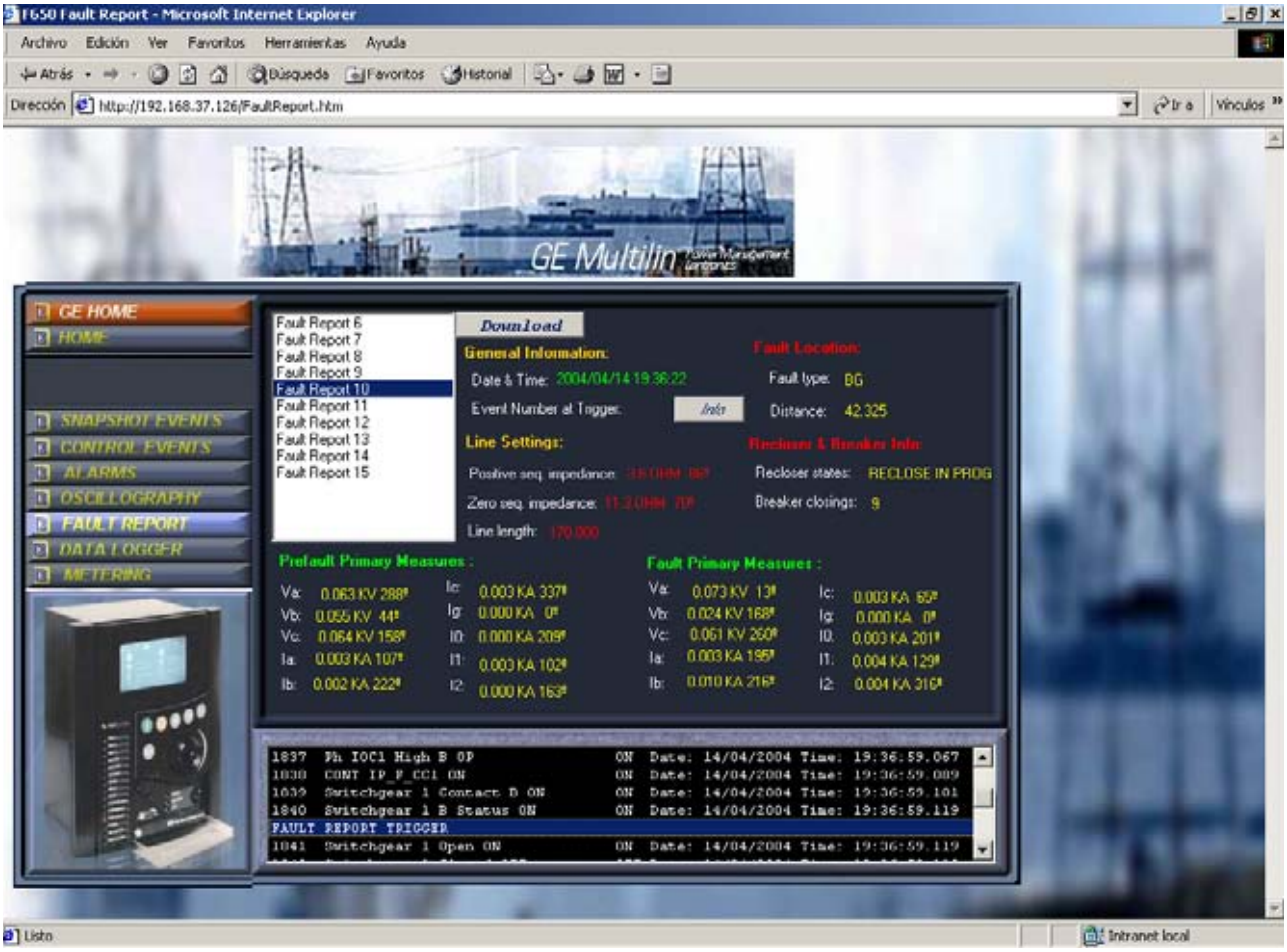


Figure 3–40: FAULT REPORT SCREEN

The information provided in this screen includes the date and time when the fault was registered, fault calculations such as distance to the fault, type of fault, date and time, and the line parameters, as well as the recloser and breaker status during the fault.

This screen shows also prefault and fault voltage and current primary values. At the top of the screen, associated to the trigger event number there is a button labeled as **INFO**. This button displays at the bottom of the screen the events produced before and after the fault report trigger, so that the user has very useful information about the moment when the fault was produced.

To obtain a text file with all the fault report information, press the ***Download*** option and save the file in the computer.

3.3.7 DATA LOGGER

The data logger screen allows viewing the data logger first and last value retrieval date and allows downloading the data record files in Comtrade format, by pressing the ***Download*** option. Stored files can be viewed later using any Comtrade format viewer.

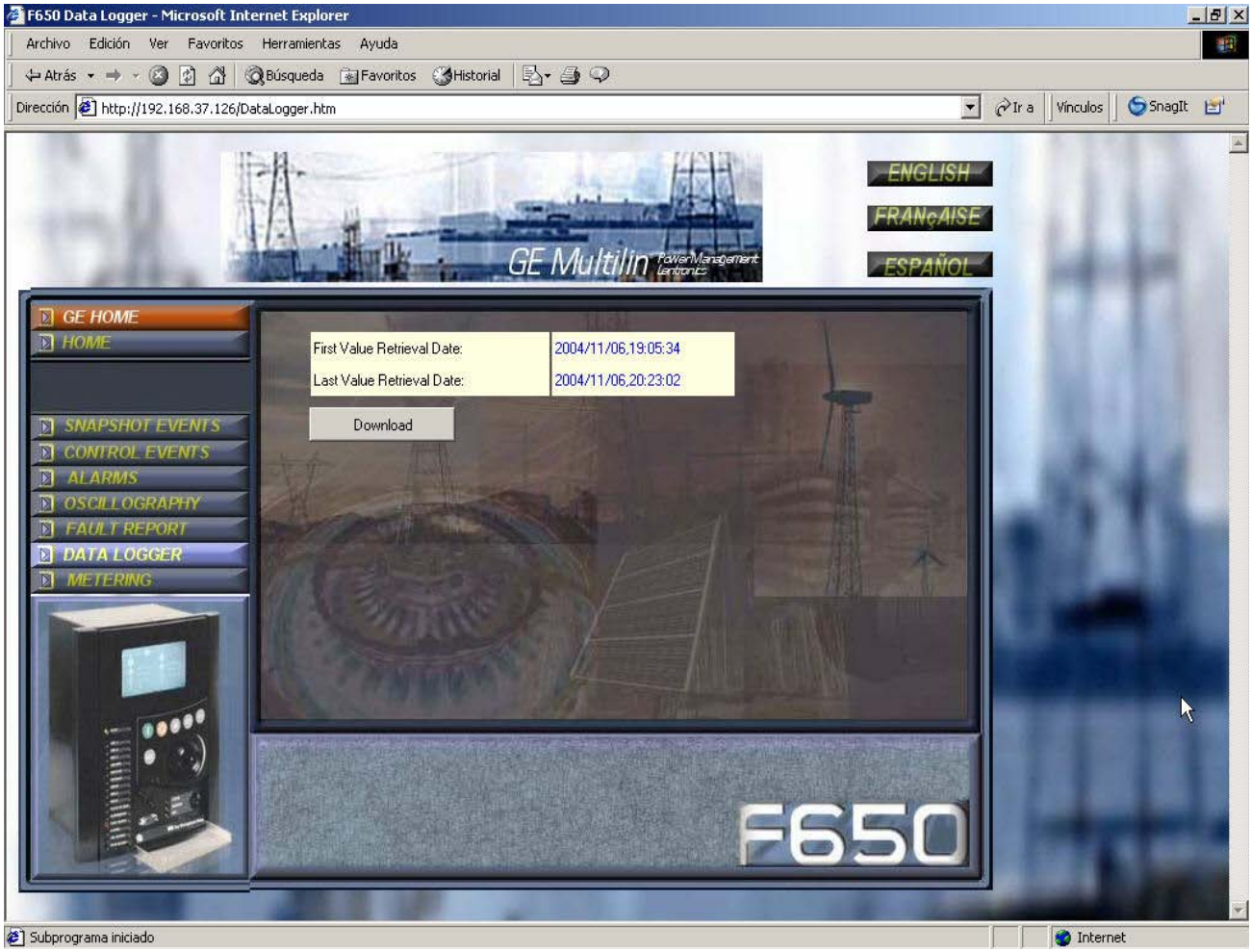


Figure 3–41: DATA LOGGER SCREEN

This screen includes the 53 primary metering values provided by the relay display.

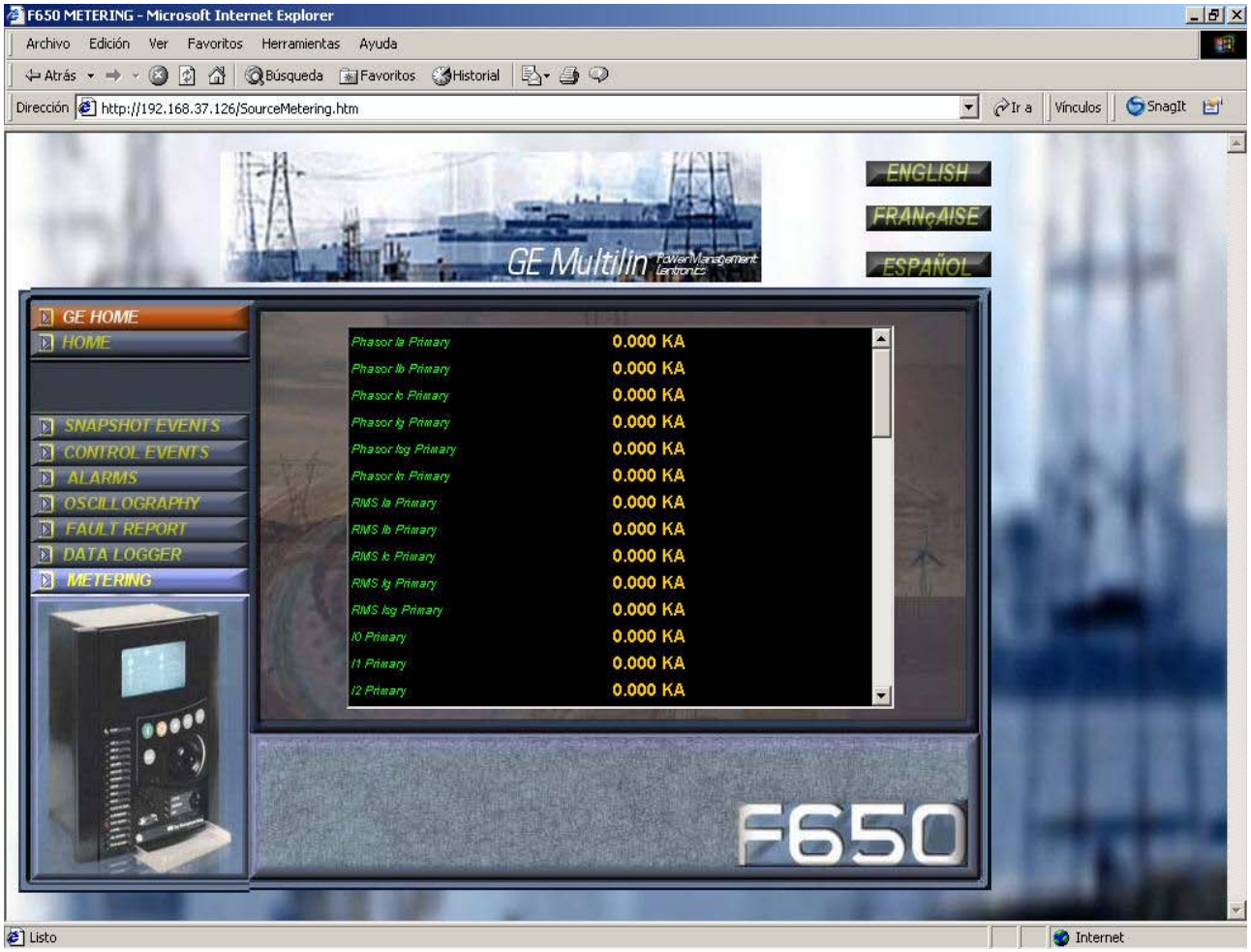


Figure 3–42: METERING SCREEN

New users can only be added by users that have **Administrator Access (or Admin Rights)** . The **Enable Security** check box located in the **Security**->**User Management** window must be enabled.

Remember: (**In order to add new users and assign user rights**)

- **must be logged in with Administrator Permission**
- and Enable Security **checkbox must be enabled**

4.1.1 USER RIGHTS

NOTE: Only Administrators have access to the User Management dialog box.
Following is a list of all of the User Rights Options available to be granted to users, and their functions.

Table 4–1: USER RIGHTS AND FUNCTIONS

RIGHT	FUNCTION
Delete Entry	If this box is checked when the Administrator exits the User Management dialog box, the program will ask you to confirm the delete and if the Administrator chooses "yes", then the user whose "Delete Entry" box was checked will be permanently deleted from the list.
Admin.	WARNING: When this box is checked, the user will become an EnerVista 650 Setup Administrator, therefore receiving all of the Administrative rights.
Actual Values	When this box is checked, the user will have the ability to *view* **Actual Values** and all records excluding event recorder.
Settings	When this box is checked, the user will have access to *view and modify* **Settings (Protection, control, inputs/ outputs and calibration)**.
Commands	When this box is checked, the user will be able to use **Commands**.
Event Recorder	When this box is checked, the user will have access to use **Event Recorder**.
Force IO	When this box is checked, the user will be able to use **Force IO** application.
Logic Configuration	When this box is checked, the user will have the ability to *view and modify* **Relay Configuration and Logic Configuration**.
Upgrade	When this box is checked, the user will have the ability to **upgrade firmware, bootware** and to **upload** and **download info files to/from relay.**

Users will be prompted to change their password after the first successful log in or through clicking **Security** from the toolbar, and choose **Change Password**.

Change Password
Enter Old Password
Enter New Password
Re-enter New Password
Enter a personal question that only you know the answer to. This will be used if you ever forget your current password and would like to know what it is.
Correct answer
Change
Cancel

Figure 4–1: CHANGE SECURITY

When the operator enters a new password for the first time, he/she should also enter a personal question that only they could answer. There is a limit of 50 characters available to enter the personal question. One example, as in the above diagram, would be "What is my mother's maiden name?". This question will be posed to the user if the user forgets their password and would like to know what their password was.

EnerVista UR Setup Security Control is disabled by default. Users don't have to log in through user name and password after installation and are granted access as Administrator.

Security Control can be enabled through **Security** from the tool bar when logged on as an Administrator. Click on **User Management** and a dialog box will show up.

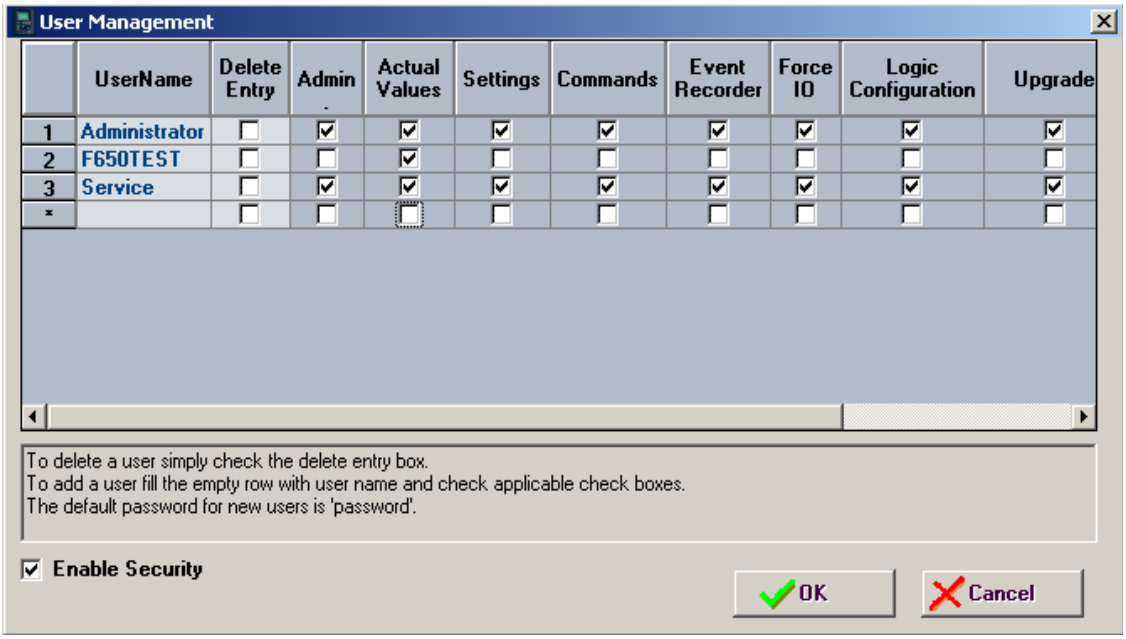


Figure 4–2: SECURITY ENABLING

Security Control is enabled by checking the **ENABLE SECURITY** check box. The first time the enable security option is selected is necessary to close and open EnerVista 650 Setup to start working under security management.

Users have to log on in order to use EnerVista 650 Setup program after Security Control has been enabled. After the start up of EnerVista 650 Setup, a dialog will pop up asking for user name and password.

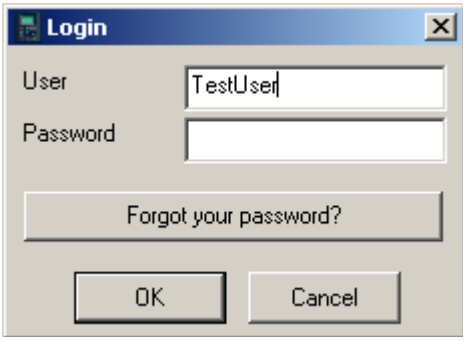


Figure 4–3: LOGIN USER

The user name field will display the last log in user name as default, in this example, TestUser. For the first log in session of any user name, the default password will be "password". User will be prompt to change the password to something else after the first successfully log in.

Log on can also be done by clicking **Security** from the toolbar and choose **Login New User**. User will be prompted with the same log in dialog box for a different user name and password combination.

In case a user has forgotten about the log in password, the **Forgot Password** function can be used to retrieve the password.

Figure 4–4: FORGOT YOUR PASSWORD?

A question, which is pre-set by the user, will be asked. The password will be retrieved for entering the right answer.

This section describes the necessary steps to update the F650 operative system and firmware.

WARNING
BEFORE PERFORMING THE UPDATE PROCEDURE CHECK THAT BOOT AND FIRMWARE VERSION MATCH

The operative system and firmware versions can be seen in the relay main screen: After the text “F650”, appears the relay firmware version (1.20 in the example), and between parenthesis the boot program version (2.20 in the example), followed by “ GENERAL ELECTRIC”, the relay model and the default front RS232 port communication parameters.

Figure 5–1: MAIN SCREEN

BOOT CODE RELEASE NOTES

It is mandatory to maintain version compatibility between firmware and boot code in the update procedure, otherwise the relay will not start after the updating procedure (if the versions are wrongly matched).

FIRMWARE AND BOOT VERSIONS COMPATIBILITY		
FIRMWARE VERSION	**BOOT VERSION**	**BOOT CODE RELEASE NOTES**
2.20	**4.00**	Minor changes in firmware. All models excepting: • Options 4 and 5 for I/O boards • Option 6 for IEC 61850 protocol
1.82	4.00	File system management enhancement in boot code 4.00 Measurements enhancement in 1.82 firmware version. All models excepting: • Options 4 and 5 for I/O boards • Option 6 for IEC 61850 protocol
2.00	3.00	New hardware options supported (see ordering code). New communication protocols supported (IEC 61850)
1.6X-1.7X-1.80	2.40	Minor changes in bootcode. No functionality change for user.
	2.35	System memory tool provided. Upgrade from 2.30 required to work with 1.61 firmware version up to 1.80
1.3X-1.4X-1.5X	2.30	Enhanced internal watchdog usage. No functionality change for user. Upgrade from 2.20 not required
1.13-1.2X	2.20	Upgraded for use with version 1.13 or later firmware
1.00-1.11	2.00	Original boot code version

NOTE
The end of this section includes a STEP LIST SUMMARY that will allow the user to control the updating process. It is necessary to read the whole document before accomplishing the F650 UPDATE PROCEDURE related in these pages.
Notice that boot program and firmware upgrades will erase all the data contained in the relay, thus it is advisable to save all the data, oscillography, events, settings and configuration files previously.
Backward compatibility of PLC projects, settings and configuration files is not assured for versions older than 1.13.

NOTE
RELAYS WITH FIBER OPTIC ETHERNET
The update of the boot program (BOOTCODE) will be performed, obligatorily, by crossed copper cable connected to the PC. It is not necessary to change the internal switch from fiber to RJ45, because the upgrade it is made at 10Mb/s and for that reason there is not conflict between copper/fiber optic.
This does not apply to the firmware upgrade, which can be done either via Ethernet Fiber connection, or through the RJ45 cable connection.

Before proceeding with the update process, the following points should be taken into account:

Type of Ethernet connection:

If the relay is connected through a hub or to a switch, a direct 10/100 Base TX Ethernet cable should be used, or with its fiber optic if the relay is of 100FX Ethernet. Otherwise, a direct connection from the PC to the relay (back-to-back) requires a crossover 10/100 Base T cable.

It is highly recommended to use a crossover cable to do the update process and do a direct connection from the PC to the relay instead of being connected through a hub or switch.

Relay IP address:

It is necessary to assign a valid IP address to the relay in the Ethernet parameters via HMI in the “Product Setup > Communication > Ethernet > Ethernet 1” menu or via EnerVista 650 Setup in “Setpoint > Product Setup>Communication Settings > Network (Ethernet) 1” as shown in Table 5–1: .

Table 5–1: ETHERNET PARAMETERS

PRODUCT SETUP>COMMUNICATION SETTINGS >NETWORK (ETHERNET) 1			
Name	Value	Units	Range
IP Address Oct1	192		[0 : 255]
IP Address Oct2	168		[0 : 255]
IP Address Oct3	37		[0 : 255]
IP Address Oct4	240		[0 : 255]
Netmask Oct1	255		[0 : 255]
Netmask Oct2	255		[0 : 255]
Netmask Oct3	255		[0 : 255]
Netmask Oct4	0		[0 : 255]
Gateway IP Oct1	192		[0 : 255]
Gateway IP Oct2	168		[0 : 255]
Gateway IP Oct3	37		[0 : 255]
Gateway IP Oct4	10		[0 : 255]

In the case of relay that has updated previously its Bootcode (Sections 2), the IP address already has been assigned in the previous process (see Figure 5–14:).

In both cases, it is necessary to check that there is no other equipment connected with the same IP address in the same net, to avoid collision.

In case of a back-to-back connection from a PC to the relay (through a crossover Ethernet cable), the IP address of the relay needs to be compatible with the TCP/IP configuration of the computer.

For example, if the relay settings are:

IP address: 192.168.37.240,

Netmask: 255.255.255.0 and

Gateway: 192.168.37.10.

The computer settings have to follow the model:

IP address: 192.168.37.XXX

Netmask: 255.255.255.0 and

Gateway: 192.168.37.10 (if desired).

XXX is a number between 0 and 255 that is not assigned to any other device to avoid collisions.

If there are not TCP/IP settings according to this model in the computer, it should be added (in order to communicate with the relay) following these steps:

Go to the **Control Panel** of the computer and select the **Network** option (the name of this option may depend on the PC operative system).

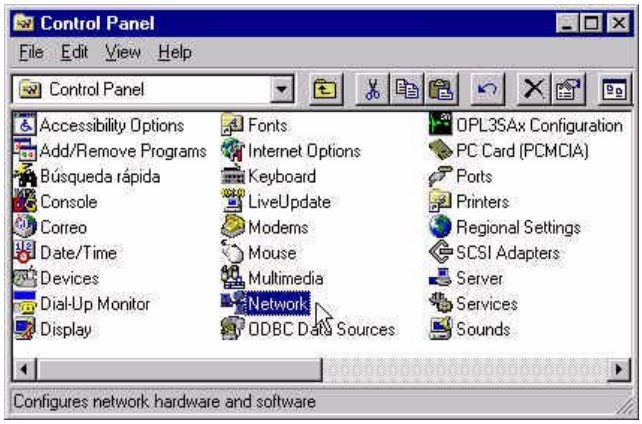


Figure 5–2: NETWORK IN CONTROL PANEL

In **Network,** enter in **Protocols** and select **TCP/IP protocol** by clicking on **Properties**.

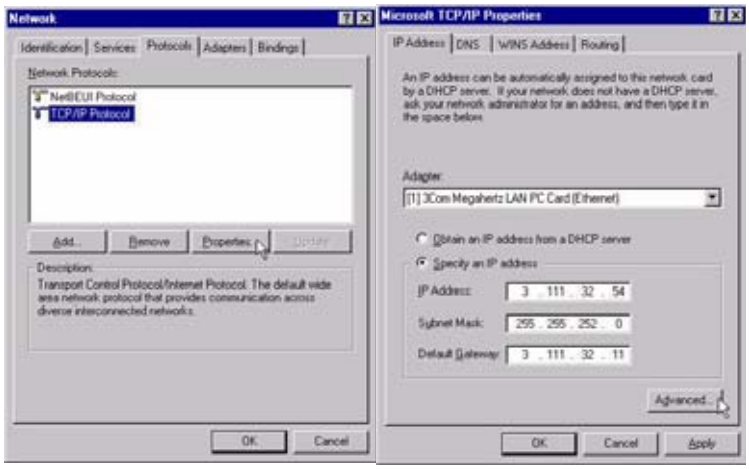

Network
Identification Services Protocols Adapters Bindings
Network Protocols:
NetBEUI Protocol
TCP/IP Protocol
Add... Remove Properties... Update
Description:
Transport Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.
OK Cancel
Microsoft TCP/IP Properties
IP Address DNS WINS Address Routing
An IP address can be automatically assigned to this network card by a DHCP server. If your network does not have a DHCP server, ask your network administrator for an address, and then type it in the space below.
Adapter:
[1] 3Com Megahertz LAN PC Card (Ethernet)
Obtain an IP address from a DHCP server
Specify an IP address
IP Address: 3 . 111 . 32 . 54
Subnet Mask: 255 . 255 . 252 . 0
Default Gateway: 3 . 111 . 32 . 11
Advanced...
OK Cancel Apply

Figure 5–3: TCP/IP PROPERTIES

5

In **IP address** tab, select **Advanced...** (Figure 5–3: TCP/IP PROPERTIES) and add a new address in the PC that corresponds to the same LAN that the relay has (in the example bellow 192.168.37.54).

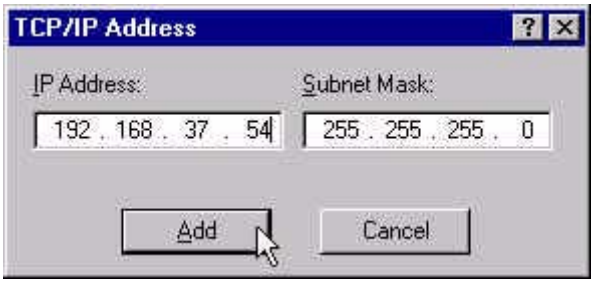


Figure 5–4: IP ADDRESS FOR COMPUTER

Windows allows Multihosting, so it permits having as many directions as desired. It is necessary to turn off and on the computer to activate the new address that has been assigned to the PC.

Operating system update is performed using EnerVista 650 Setup. For this purpose, it is required that there is no communication between the program and the relay, and that no configuration file is open.

In this case, menu option ***Upgrade Operating System*** will be enabled under the EnerVista 650 Setup ***Communication*** menu.

During the operative system updating process, all the data stored in the relay will be lost, so it is required to save all calibration, settings, oscillography, etc. from the relay before the upgrade. It is extremely important to save the relay settings and calibration before continuing with the process. In this step of the updating process if the user do not want to continue, click on the NO option and no change will be perform to the relay.

EnerVista F650 Setup
All RELAY INFORMATION will be LOST!.
Please, be sure of having saved CALIBRATION SETTINGS, PROTECTION and CONTROL SETTINGS, and RELAY CONFIGURATION before upgrading.
Do you want to proceed?
Sí
No

Figure 5–5: LOST DATA WARNING MESSAGE

For upgrading the operative system, it is required to connect an RS232 cable to the front of the relay, and an Ethernet cable to the rear port (COM3). The serial communication parameters will be the ones selected in the ***Communications > Computer*** menu, where the COMX port (the port to be used in the upgrade) must be selected. As regards Ethernet communication, if the upgrade is to be performed through a hub or switch, it is required to connect the relay to the hub or switch through a direct 10/100 base T cable.

If the connection is made directly from the PC to the relay it is necessary to use a 10/100 Base T crossover cable. This last connection will be obligatory for relays with Fiber Optic Ethernet, although it will not be necessary to change the internal switch. During the upgrade, the system will show the following message indicating the procedure to be followed.

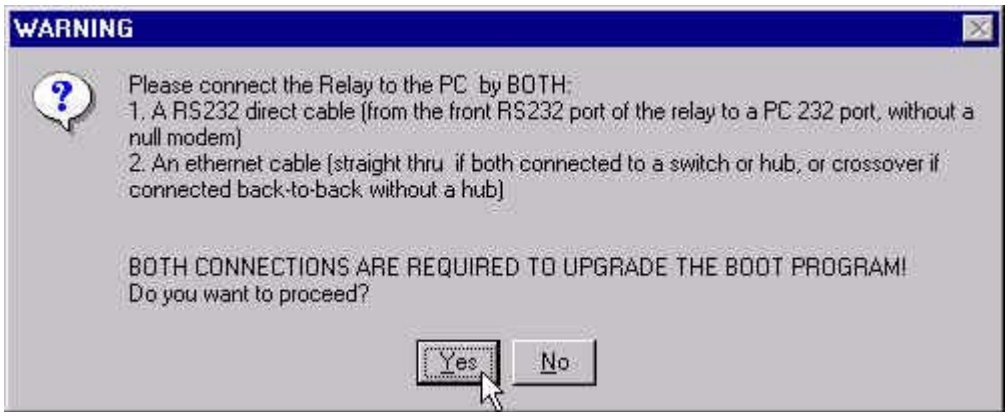

WARNING
Please connect the Relay to the PC by BOTH:
1. A RS232 direct cable (from the front RS232 port of the relay to a PC 232 port, without a null modem)
2. An ethernet cable (straight thru if both connected to a switch or hub, or crossover if connected back-to-back without a hub)
BOTH CONNECTIONS ARE REQUIRED TO UPGRADE THE BOOT PROGRAM!
Do you want to proceed?
Yes
No

Figure 5–6: SERIAL AND ETHERNET CONNECTIONS FOR BOOT UPDATE

NOTE
To obtain more information about the Relay network configuration, please refer to section 5.1.1 COMMUNICATION PARAMETERS

After accepting to proceed, a window will open up for selecting a temporary IP Address for the boot update. It is advisable to set the IP Address that is going to be used lately in the relay for Ethernet connection.

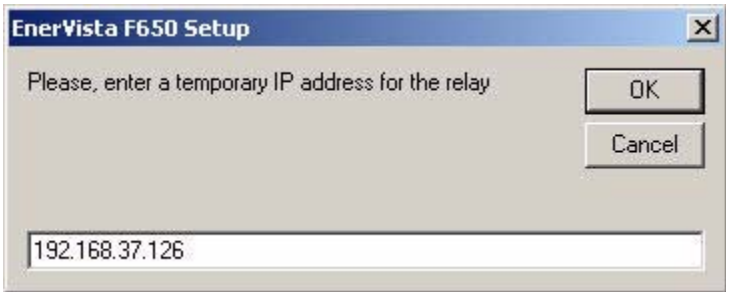


Figure 5–7: TEMPORARY IP ADDRESS SELECTION FOR BOOT UPDATE

After entering the temporary IP address, a window will open up for selecting the appropriate file from the GE Multilin web site or Product CD.

Figure 5–8: BOOT FILE SELECTION

Once the appropriate boot program file has been selected, the program will proceed to load and update the relay's boot memory.

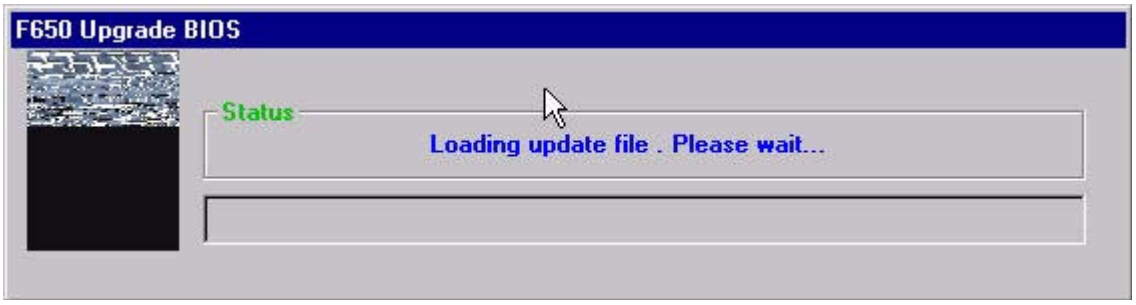


Figure 5–9: LOADING BOOT FILE

After the boot memory loading, the program shows a message requiring turning off and back on the relay while the progress bar is in course.

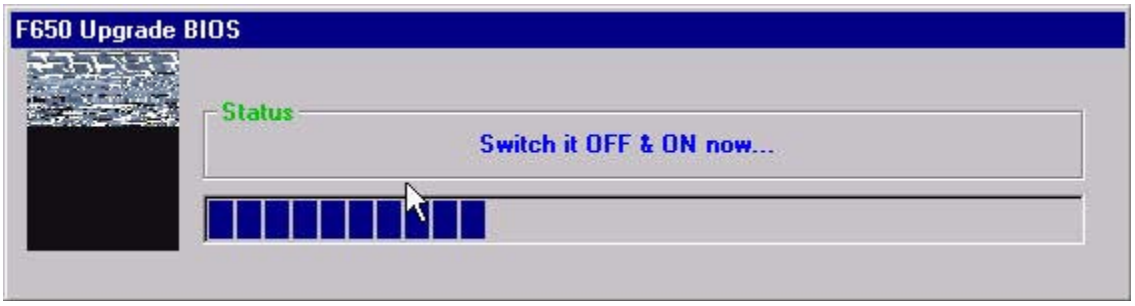


Figure 5–10: SWITCH THE RELAY OFF AND ON TO START THE BOOT PROCEDURE

It is important to turn the Relay off and on again during the time shown by the progress bar; in case this time expires, the program will offer the option to continue with the process or to postpone, verify the correct RS232 connections and try again later. Notice that the serial port used in the boot update procedure is the one selected in the "***Communication>computer***" menu.

Figure 5–11: ERROR MESSAGE FOR COMMUNICATIONS PROBLEMS

If the serial communication between EnerVista 650 Setup and the relay has been successful the program shows a message to select to update the current version to the new one.

Figure 5–12: UPDATE CURRENT VERSION?

At this moment, selecting **"YES"** in the **"Update current version?"** option will start, beginning with the relay flash memory deletion, so at this point all the information stored in the relay will be lost.

Until now, no important change has been made to the relay, the boot memory updating process has simply been prepared.

The process of flash memory erasing and boot memory file loading can take some minutes, during which a progress bar is displayed.

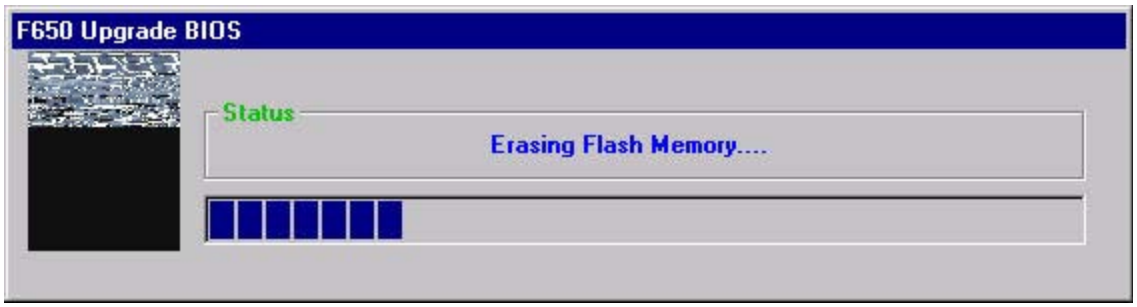


Figure 5–13: ERASING FLASH MEMORY

Once the memory has been erased and the files updated in the relay, the parameters for the Ethernet communications parameters must be assigned (Figure 5–14:). The requested values are the IP address and the gateway

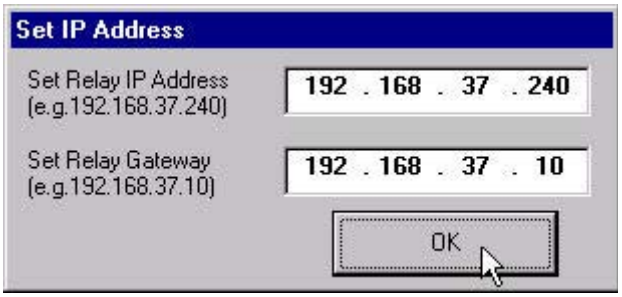


Figure 5–14: ETHERNET PARAMETERS

These values should match the LAN structure in which the relay will be connected.

The gateway must be the one used in the LAN structure connecting the relay. The relay IP address should have the first three octets corresponding with the Gateway and the last octet must be a free IP address reserved to the relay to avoid possible collisions with other devices.

After assigning the Ethernet parameters, the update of the boot memory program has been completed successfully .

Figure 5–15: BOOT PROGRAM UPDATED

After boot memory update, the equipment firmware must also be updated (Section 5.3).

The F650 equipment includes a mechanism that allows the update of the internal program called firmware, to new versions that are periodically published in the GE Multilin web.

The relay settings and configuration will be lost, so it is advisable to save them to a file. For firmware revisions lower than 1.50, it is required to save calibration settings in a file before updating the F650 to a new firmware version. In case of versions higher than 1.50, the calibration retrieval process is automatic and it is not necessary to save them to a file (nevertheless is always advisable to do it). Take into account that if the operative system (bootcode) has been previously updated, all the data (including calibration settings) would be lost.

In case of error during the firmware updating process, the user could repeat the whole process as many times as necessary, this is possible thanks to an independent boot memory (bootcode).

The firmware updating process should be done through the EnerVista 650 Setup software, after connecting the relay by Ethernet port (COM3).

5.3.1 FIRMWARE UPDATE

Once the communication with the relay through Ethernet connection has been verified[1], enter the EnerVista 650 Setup program, select **Communication** and the **Upgrade Firmware Version** option.

At this point, proceeding with the update will erase all the data stored in the equipment, including the calibration settings in firmware version previous to 1.50. Therefore, it is necessary to save all settings to a file before following with the process.

After accepting to proceed, a window will open up for the update parameter for the F650 firmware update process. In firmware version previous to 1.70 the EnerVista 650 Setup program asked for the IP address of the relay to be updated and its serial number. In versions 1.70 and higher it is also necessary to enter the ordering code for the relay. See figure below:

This change is due to the multilingual implementation in F650 devices. See ordering code section in product description chapter in this manual.

Figure 5–16: FIRMWARE SELECTION WINDOW

1. Calibration settings should be stored in a file before updating the firmware.

Go to EnerVista 650 Setup main menu "***Communication > Calibration > Get Calibration Settings***"

Store the file in the PC using the relay serial number, for instance, as the name of the file.

Once the upgrade parameters have been entered, relay IP address, serial number and ordering code, press the **"Upgrade Firmware"** button. When communication has been established, the program will show a message requesting to turn off and back on the relay to continue with the upgrade process.

Once the relay has been turned off and on again, a new screen allows selecting the folder that contains the firmware update files ("update.txt" file must be located in this folder). This Update.txt file is located in the folder where the desired firmware upgrade files are. This firmware update files can be found in the GE Multilin web site.

If the files are downloaded from the web, they are compressed in a zip file. It should be decompressed in a temporary directory from which the update.txt file will be selected.

Once the Update.txt file is selected, the "Upgrade Firmware" button will be enabled. Press this button to initiate the relay firmware upgrade process. A voltage range selection window will appear, this voltage range is connected to the serial number of the relay. The EnerVista 650 Setup program automatically pre-selects the appropriate voltage range for the unit. If the voltage range is not selected correctly the error in voltage measurements will be 20 %.

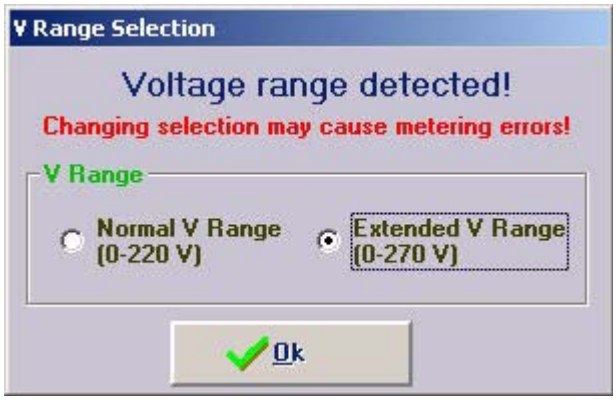


Figure 5–17: VOLTAGE RANGE SELECTION

During the process, the program displays the files that are being updated. When the file transfer is finished, a message appears noticing that it is necessary to wait sometime before resetting the unit, in order to start working with the new firmware version in the relay. When the whole process has finished a message will be displayed asking to reboot the F650.

At this point, the firmware upgrade procedure is finished and the relay ready to be powered down and back up to check that the firmware has been upgraded properly.

When upgrading the firmware the entire settings and relay configuration are reset to factory default value.

Once the equipment has been properly checked, the F650 is ready to be used.

Remember that calibration settings and configuration must be loaded to the relay. To recover the relay calibration:

Go to EnerVista 650 Setup main menu:

Communication > Calibration > Set calibration Settings to store in the relay the calibration settings if necessary.

File > Config file (*.650) Converter to convert the setting and configuration file *.650 for the relay (if is was in a previous version format) to the new version (see section 3.1.6 File MENU OVERVIEW in human interfaces in this manual)

File > Send info to relay to send the new settings and configuration file to the unit.

Notice that boot program and firmware upgrade will erase all the data contained in the relay, thus it is advisable to save all the data, oscillography, events, settings and configuration files previously.

5.4.1 BOOT MEMORY UPDATE (*)

1. NSTALL THE PROPER VERSION OF THE ENERVISTA 650 Setup PROGRAM.
2. CONNECT AN RS-232 CABLE IN THE FRONT PORT OF THE RELAY AND ETHERNET ONE AT THE REAR ETHERNET PORT (CROSSOVER CABLE FOR BACK-TO-BACK CONNECTION AND DIRECT ETHERNET CABLE FOR HUB OR SWITCH).
3. GET CALIBRATION SETTINGS (AND SAVE IT TO A FILE).
4. SAVE ALL THE DATA FROM THE RELAY (SETTINGS, OSCILLOGRAPHY, EVENTS).
5. FROM THE ENERVISTA 650 Setup PROGRAM SELECT COMMUNICATION/UPGRADE OPERATING SYSTEM.
6. FOLLOW THE INDICATIONS OF THE PROGRAM AND SELECT THE BOOT PROGRAM BIN FILE.
7. WHEN REQUIRED BY THE PROGRAM SWITCH OFF AND BACK ON THE RELAY.
8. CONTINUE WITH THE PROCESS AND SET THE IP ADDRESS AND GATEWAY WHEN REQUIRED.

5.4.2 FIRMWARE UPDATE (*)

1. SET THE APPROPRIATE IP ADDRESS IN THE RELAY.
2. SET THE APPROPRIATE IP ADDRESS IN THE PC.
3. FROM THE ENERVISTA 650 Setup PROGRAM SELECT “COMMUNICATION/UPGRADE SOFTWARE VERSION”.
4. ENTER THE IP ADDRESS, SERIAL NUMBER AND ORDERING CODE OF THE RELAY TO UPDATE.
5. WHEN REQUIRED BY THE PROGRAM SWITCH OFF AND BACK ON THE RELAY.
6. LOCATE THE UPDATE.TXT FILE ACCORDING TO THE MODEL OF THE RELAY.
7. PRESS UPGRADE FIRMWARE AND INITIATE THE UPGRADE PROCESS.
8. TO COMPLETE THE PROCEDURE, SWITCH OFF AND BACK ON THE RELAY WHEN REQUIRED BY THE PROGRAM.
9. SET CALIBRATION SETTINGS (FROM THE PC TO THE RELAY) (for versions lower than 1.50).
10. THE SETTINGS AND CONFIGURATION ARE NOW SET TO FACTORY DEFAULT.
11. SEND THE NEW SETTINGS AND CONFIGURATION FILES TO THE RELAY IF NECESSARY.

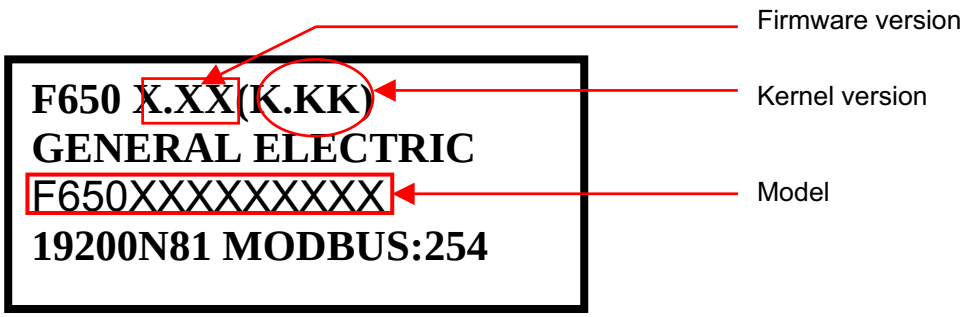
(*) The boot code upgrade must be performed using a crossed copper cable (RJ45) connected to the PC. It is not necessary to modify the internal fiber/cable switch, as the upgrade is carried out at 10 Mb/s, and thus there is not cable/fiber conflict.

This fact does not apply to the firmware upgrade, which can be performed either with the Ethernet fiber connection, or with the cable connection.

Verify that the relay has not suffered any damage during transportation, and that all screws are correctly fixed, and all relay terminal boards are in good condition.

Verify that the information shown on the relay front plate corresponds to the data shown on the display, and to the requested relay model.

Display information:



All devices running on AC current are affected by frequency. As a non-senoidal wave is the result of a fundamental wave plus a series of harmonics from this fundamental wave, it can be deducted that devices running on AC current are influenced by the applied waveform.

For a correct testing of relays running on AC current, it is fundamental to use a current and/or voltage senoidal waveform. The pureness of a senoidal wave (lack of harmonics) cannot be expressed specifically for a specific relay. However, any relay incorporating sintonized circuits, R-L and R-C circuits, will be affected by non-senoidal waveforms, as in the case of F650.

These relays respond to the voltage waveform in a different way to the majority of AC current voltmeters. If the power supply network used for the testing contains wide harmonics, the voltmeter and relay responses will be different.

Relays have been calibrated in factory using a Network of 50 or 60 Hz with a minimum harmonic content. When the relay is tested, a power supply network with no harmonics in its waveform must be used.

The ammeters and chronometers used for testing the pickup current and relay operation time must be calibrated and their accuracy must be better than the relay's. The power supply used in the tests must remain stable, mainly in the levels near the operation thresholds.

It is important to point out that the accuracy with which the test is performed depends on the network and on the instruments used. Functional tests performed with unsuitable power supply network and instruments are useful to check that the relay operates properly and therefore its operating characteristics are verified in an approximate manner. However, if the relay would be calibrated in these conditions, its operational characteristics would be outside the tolerance range values.

The following sections detail the list of tests for verifying the complete relay functionality.

During all tests, the screw located on the rear of the relay must be grounded.

For verifying isolation, independent groups will be created, and voltage will be applied as follows:

2200 RMS volts will be applied **progressively** among all terminals in a group, short-circuited between them and the case, during one second.

2200 RMS volts will be applied **progressively** between groups, during one second.

WARNING: No communication circuit shall be tested for isolation.

Groups to be created will depend on the type of modules included in F650, selectable according to the model.

The following table shows the different groups depending on the module type:

SOURCE 1:	**SOURCE 2:**	**MAGNETIC MODULE.**
G1: H10, H18	**G1**: H1, H9	**G1**: A5..A12
G2: H13, H14, H15	**G2**: H4, H5, H6	**G2**: B1..B12
I/O F1 (MIXED)	**I/O F2 (SUPERVISION)**	**I/O G1 (MIXED)**
G1 (Inp. 1): F1..9	**G1** (Spv 1): F1..4	**G1** (Inp. 1): G1..9
G2 (Inp. 2): F10..18	**G2** (Inp. 1): F5..9	**G2** (Inp. 2): G10..18
G3 (Out.): F19..36	**G3** (Inp. 2): F10..14	**G3** (Out.): G19..36
	G4 (Spv 2): F15..18	
	G5 (Out.): F19..30	
	G6 (Out.): F31.36	

Feed the relay and verify that when commanding a LED reset operation, all LED indicators light up and they are turned off when pressing the **ESC** key for more than 3 seconds.

Feed the relay to the minimum and maximum voltage. For each voltage value, verify that the alarm relay is activated when there is voltage, and it is deactivated when there is no feed. If the power supply source incorporates AC feed, this test will be performed also for VAC.

If the relay incorporates a redundant power supply, these tests shall be performed on both power supplies.

Voltage values to be applied will be the ones indicated below according to the relay model:

SUPPLY	V MIN.	V MAX.
HI/HIR 110-250 Vdc 120-230 Vac	 88 Vdc 96 Vac	 300 Vdc 250 Vac
LO/LOR 24-48 Vdc	 20 Vdc	 57.6 Vdc

NOTE: Codes HIR and LOR correspond to a redundant power supply

Verify that available communication ports allow communication with the relay.

Ports to be checked are as follows:

Front:RS232

Rear:2 x RS485, 2 x Fiber Optic - Serial, 2 x Fiber Optic - Ethernet, 1 x RJ45 - Ethernet.

A computer with EnerVista 650 Setup software and an appropriate connector must be used.

Set the relay as follows

GENERAL SETTINGS			
NAME	**VALUE**	**UNITS**	**RANGE**
PHASE CT RATIO	1.0	0.1	1.0-6000.0
GROUND CT RATIO	1.0	0.1	1.0-6000.0
STV GROUND CT RATIO	1.0	0.1	1.0-6000.0
PHASE VT RATIO	1.0	0.1	1.0-6000.0
PHASE VT CONNECTION	WYE	N/A	WYE – DELTA
NOMINAL VOLTAGE	100 V	0.1	1-250 V
NOMINAL FREQUENCY	50 Hz	1 Hz	50-60 Hz
PHASE ROTATION	ABC	N/A	ABC – ACB
FREQUENCY REFERENCE	VI	N/A	VI-VII-VIII
AUXILIARY VOLTAGE	VX	N/A	VX – VN

NOTE:

ALL ANGLES INDICATED ARE DELAY ANGLES

ALL VALUES OBTAINED IN THIS TEST MUST BE THE ONES CORRESPONDING TO THE DFT

6.7.1 VOLTAGES

Apply the following current and frequency values to the relay:

CHANNEL	ANGLE	FREQUENCY					
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
VI	0º	0	5	50	100	150	275
VII	120º	0	5	50	100	150	275
VIII	240º	0	5	50	100	150	275
VX	0º	0	5	50	100	150	275

Verify that the relay measures the values with an error of +/-1 % of the applied value plus 0,1% of full scale (275V).

6.7.2 PHASE CURRENTS

Apply the following voltage and frequency values to the relay:

CHANNEL	ANGLE	FREQUENCY					
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
Ia (A)	45º	0	15	10	5	1	0.1
Ib (A)	165º	0	15	10	5	1	0.1
Ic (A)	285º	0	15	10	5	1	0.1
IG(A)	0º	0	15	10	5	1	0.1
ISG(A)	0º	0	5	1	0.1	0.01	0.005

Verify that the relay measures the values with an error lower than +/-0.5% of the test value or+/- 10 mA, whichever is greater, for phases and ground.

Verify that the relay measures the values with an error lower than +/-1.5% of the test value or+/- 1 mA, whichever is greater, for sensitive ground (SG).

6.7.3 ACTIVE, REACTIVE POWER, AND COSϑ METERING

Equations to be applied for powers in a wye connection are as follows:

POWER PER PHASE	THREE-PHASE POWER
P=V*I*Cosφ	P=Pa+Pb+Pc
Q=V*I*Senφ	Q=Qa+Qb+Qc

Apply the following current and voltage values:

APPLIED VOLTAGE AND CURRENT VALUES PER PHASE			
PHASE A	**PHASE B**	**PHASE C**	**V-I ANGLES**
VI = 50 V, 0º	VII = 50 V , 120º	VIII = 50V, 240º	φ=45º
Ia = 10∠45º	Ib= 10∠165º	Ic = 10∠285º	**Cosφ= 0.707**

With the indicated voltage and current values, verify that the power measure corresponds to theoretical values indicated in the following table:

THEORETICAL POWER VALUES			
PHASE A	**PHASE B**	**PHASE C**	**THREE-PHASE**
Pa = 353.55 MW	Pb = 353.55 MW	Pc = 353.55 MW	P = 1060.66 MW
Qa = 353.55 MVAr	Qb = 353.55 MVAr	Qc = 353.55 MVAr	Q = 1060.66 MVAr

Maximum admissible error is +/-1% of the test value for P and Q, and 0.02 for cosφ.

6.7.4 FREQUENCY

Frequency measure on channel VII (terminals A7-A8):

Apply 50 Vac at 50 Hz on channel VII. Maximum admissible error:+/- 10 mHz.

Apply 50 Vac at 60 Hz on channel VII. Maximum admissible error: +/- 12 mHz.

Frequency measure on channel Vx (terminals A11-A12):

Apply 50 Vac at 50 Hz on channel Vx. Maximum admissible error:+/- 10 mHz.

Apply 50 Vac at 60 Hz on channel Vx. Maximum admissible error: +/- 12 mHz.

Results:

CHANNEL	VOLTAGE (V)	SET FREQUENCY (HZ)	MEASURED FREQUENCY (HZ)
VII	50	50 Hz	
		60 Hz	
VX	50	50 Hz	
		60 Hz	

During all tests, the screw on the rear of the relay must be grounded.

6.8.1 DIGITAL INPUTS

During this test, the user will determine the activation/deactivation points for every input in the relay for the set voltage value of 30 Volts.

Verify that the error does not exceed +/- 10% (+10% on activation, -10% on deactivation)

Default board settings for the input test can be modified in EnerVista 650 Setup software in:

Settings>Inputs/Outputs>Contact I/O>Board X

X, will be substituted by the corresponding board:

F for board in first slot

G for board in second slot

H for board in first slot of CIO module

J for board in second slot of CIO module

Test settings for mixed board (type 1:16 inputs and 8 outputs) :

I/O BOARD TYPE 1 (MIXED)	
Voltage Threshold A_X	30 V
Voltage Threshold B_X	40 V
Debounce Time A_X	5 ms
Debounce Time B_X	5 ms
Input Type_X_CC1 (CC1)	POSITIVE
...	...
Input Type_X_CC16 (CC16)	POSITIVE

The inputs test is completed by groups of 8 inputs, as this type of board has 2 groups of 8 inputs with the same common. For the first 8 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 8 inputs, the setting is Voltage Threshold B. Inputs (or contact converters, CC1 – CC16) must also be set to POSITIVE.

Test settings for mixed board (type 2: 8 digital inputs, 4 blocks for supervision and 8 outputs) :

I/O BOARD TYPE 2 (SUPERVISION)	
Voltage Threshold A_X	30 V
Voltage Threshold B_X	40 V
Debounce Time A_X	5 ms
Debounce Time B_X	5 ms
Input Type_X_CC1 (CC1)	POSITIVE
...	...
Input Type_X_CC8 (CC8)	POSITIVE

The inputs test is completed by groups of 4 inputs, as this type of board has 2 groups of 4 inputs with the same common. For the first 4 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 4 inputs, the setting is Voltage Threshold B. Inputs (or contact converters, CC1 – CC8) must also be set to POSITIVE.

If the relay incorporates more input modules, this test must also be applied to them.

6.8.2 CONTACT OUTPUTS

The correct activation of every output will be verified.

For every output, activation command of a single contact must be given, and then verify that only that contact is activated. Go to EnerVista 650 Setup Software (***Settings>Inputs/Outputs>Force Outputs***).

For switched contacts, the change of state of both contacts shall be verified.

6.8.3 CIRCUIT CONTINUITY SUPERVISION INPUTS

Supervision inputs will be tested as normal inputs, revising the voltage level that will be 19 Volts.

Coil 1:

Apply 19 Vdc to both 52/a (terminals F1-F2) and 52/b (terminals F3-F4)"Coil 1" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals F1-F2) and 52/b (terminals F3-F4)"Coil 1" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

Coil 2:

Apply 19 Vdc to both 52/a (terminals F15-F16) and 52/b (terminals F17-F18)"Coil 2" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals F15-F16) and 52/b (terminals F17-F18)"Coil 2" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

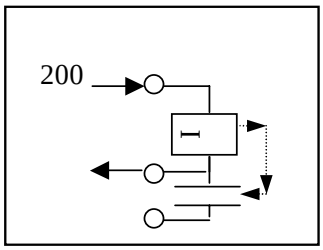
6.8.4 LATCHING CIRCUITS

Send a closing command to the latched contact (F31-F33).

Make circulate a current of 200 mA through the contact in series with the sensing terminal.

Send an opening command and verify that the contact does not open.

Interrupt current and check than the contact is released.



Repeat the test for the other latched contact (F34-F36).

Connect current sources to the relay according to the wiring diagram. Current and voltage input terminals are as follows:

PHASE	CONNECTIONS
Current	
IA	B1-B2
IB	B3-B4
IC	B5-B6
IG	B9-B10
ISG	B11-B12
Voltage	
VI	A5-A6
VII	A7-A8
VIII	A9-A10
VX	A11-A12

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Apply 0.9 times the Pickup current and check that the relay does not trip.

Gradually increase the current value and verify that the relay operates between 1 and 1.1 times the set pickup current. The relay must trip by instantaneous in a time frame of 10 to 55 ms. All the relay trip contacts must operate, as well as the contact set as 50.

Remove current and apply it again suddenly to a value of 4 times the pickup current. The relay should trip instantaneously in a time frame of 10 to 45 ms.

Test one point for each phase and group of the protection element.

50 ELEMENTS TEST PARAMETERS			
Element Settings (50PH, 50PL, 50G y 50SG)			
Setting	Value	Units	
Function	Enabled		
Input	RMS	NA	
Pickup Level	3	A	
Delay time	0	Seconds	
Test Execution			
Configure one output for 50 Trip			
Apply times I pickup	Element Trip		Tripping times (ms)
0.9 x Pickup	NO		NA
1.1 x Pickup	YES		10-55
4 x Pickup	YES		10-45
Elements	Phase		Group
50PH and 50PL	IA		0
	IB		0
	IC		0
50G	IG		0
50SG	ISG		0

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Apply 0.9 times the Pickup current and check that the relay does not trip.

Apply 1.5 times the Pickup current. The relay should trip according to the time corresponding to its set curve.

Apply 5 times the Pickup current. The relay should trip according to the time corresponding to its set curve.

PROTECTION ELEMENT SETTINGS (51PH, 51PL, 51N, 51G AND 46)						
SETTING			VALUE		UNIT	
FUNCTION			ENABLED			
INPUT			PHASOR (DFT)			
PICKUP LEVEL			1		A	
CURVE			MODIFY FOR EACH TEST			
TD MULTIPLIER			MODIFY FOR EACH TEST			
VOLTAGE RESTRAINT			DISABLED			
ELEMENT	PHASE	CURVE TYPE	DIAL	TIMES IPICKUP	TRIPPING TIMES (SEC)	
					THEORETICAL	ADMISSIBLE
51PH	IA	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.60]
				5	0.648	[0.600 – 0.710]
	IB	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]
51PL	IC	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.60]
				5	0.648	[0.600 – 0.710]
	IB	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]
51N	IC	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.60]
				5	0.648	[0.600 – 0.710]
51G	IG	Definite Time	2	0.9	NA	
				5	2.000	[1.900 – 2.100]
46	I2	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]

In order to test directional units in the relay, instantaneous trips will be commanded.

Two points will be tested, per phase, test element.

The factory default configuration of the relay makes the overcurrent elements be supervised by directional units. This way, if the directional element is enabled and detects the fault in the block direction, then the overcurrent unit will not operate. If the directional element is not enabled or if it is enabled and it detects a fault in a trip direction, then the overcurrent unit will operate if the set current level is exceeded.

6.12.1 67P ELEMENT

Activate only protection elements 50PH and 67P and set the relay as follows:

67P Settings		50PH Settings	
Function	ENABLED	Function	ENABLED
MTA	45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Block Logic	PERMISSION	Trip Delay	0.30
Pol V Threshold	30 V	Reset Delay	0.00

Configure one of the outputs to be activated only by unit 50PH.

Apply the following tests:

ELEMENTS	PHASE UNDER TEST			POLARIZATION PHASE			ELEMENT TRIP
	CHANNEL	MAGNITUDE		CHANNEL	MAGNITUDE		
		MOD	ARG		MOD	ARG	
50PH/67P	IA	2 A	0º	VIII	60 V	0º	NO
					60 V	180º	YES
	IB	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
	IC	2 A	0º	VII	60 V	0º	NO
					60 V	180º	YES

6.12.2 67N ELEMENT

Activate only protection elements 50N and 67N and set the relay as follows:

67N Settings		50N Settings	
Function	ENABLED	Function	ENABLED
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50G.

Apply the following tests:

ELEMENTS	PHASE UNDER TEST			POLARIZATION PHASE			ELEMENT TRIP
	CHANNEL	MAGNITUDE		CHANNEL	MAGNITUDE		
		MOD	ARG		MOD	ARG	
50N/67N	IA	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
	IB	0 A	0º	VII	0 V	0º	
	IC	0 A	0º	VIII	0 V	0º	

6.12.3 67G ELEMENT

Activate only protection elements 50G and 67G and set the relay as follows:

67G SETTINGS		50G SETTINGS	
Function	ENABLED	Function	ENABLED
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50G.

Apply the following tests:

ELEMENTS	PHASE UNDER TEST			POLARIZATION PHASE			ELEMENT TRIP
	CHANNEL	MAGNITUDE		CHANNEL	MAGNITUDE		
		MOD	ARG		MOD	ARG	
50G/67G	IG	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
				VII	0 V	0º	
				VIII	0 V	0º	

Activate only protection elements 50SG and 67SG and set the relay as follows:

67SG SETTINGS		50SG SETTINGS	
Function	ENABLED	Function	ENABLED
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50SG.

Apply the following tests:

ELEMENTS	PHASE UNDER TEST			POLARIZATION PHASE			ELEMENT TRIP
	CHANNEL	MAGNITUDE		CHANNEL	MAGNITUDE		
		MOD	ARG		MOD	ARG	
50SG/67SG	ISG	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
				VII	0 V	0º	
				VIII	0 V	0º	

6.13.1 27P ELEMENT

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

PHASE UV (27P)	
Function	ENABLED
Mode	PHASE-GROUND
Pickup Level	50 V
Curve	DEFINITE TIME
Delay	2.00 sec
Minimum Voltage	30 V
Logic	ANY PHASE
Supervised by 52	DISABLED

Apply voltage as indicated on the table over the undervoltage setting level and verify that the relay does not trip.

Decrease voltage level gradually and verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENT	PHASE	CURVE	PICKUP LEVEL	DELAY	APPLIED VOLTAGE	TRIPPING TIMES (S)	
						THEORETICAL	ADMISSIBLE
27P	VI	DEFINITE TIME	50 V	2	55 V	NO TRIP	NA
					45 V	2.000 sec	[2.000 – 2.100]

6.13.2 27X ELEMENT

AUXILIARY UV (27X)	
Function	ENABLED
Pickup Level	50 V
Curve	DEFINITE TIME
Delay	2.00 sec

Apply voltage as indicated on the table over the undervoltage setting level and verify that the relay does not trip.

Decrease voltage level gradually and verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENT	INPUT	CURVE	PICKUP LEVEL	DELAY	APPLIED VOLTAGE	TRIPPING TIME (S)	
						THEORETICAL	ADMISSIBLE
27X	VX	DEFINITE TIME	50 V	2	55 V	NO TRIP	NA
					45 V	2.000 sec	[2.000 – 2.100]

6.14.1 59P ELEMENT

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

PHSE OV (59P)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00
Logic	ANY PHASE

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENT	PHASE	PICKUP LEVEL (VOLTS)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	TRIPPING TIME (S)	
					THEORETICAL	ADMISSIBLE
59P	VII	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

6.14.2 59X ELEMENT

Set the relay as follows:

GENERAL SETTINGS	
Auxiliary Voltage	VX

AUXILIARY OV (59P)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00
Logic	ANY PHASE

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENT	INPUT	PICKUP LEVEL (VOLTS)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	TRIPPING TIME (S)	
					THEORETICAL	ADMISSIBLE
59X	VX	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

Set the relay as follows

GENERAL SETTINGS	
Auxiliary Voltage	VN

NEUTRAL OV HIGH/LOW (59NH/59NL)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

ELEMENTS	INPUT	PICKUP LEVEL (VOLTS)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	TRIPPING TIME (S)	
					THEORETICAL	ADMISSIBLE
59NH/59NL	VX	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

This element can also be tested by applying only phase voltages. For this purpose, it is necessary to set Auxiliary Voltage = VX. In this condition, Vn voltage is calculated as a sum of the phase voltages.

Set the relay as follows:

NEG SEQ OV (47)	
Function	ENABLED
Pickup Level	50 V
Trip Delay	2.00
Reset Delay	0.00

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

CHANNEL	APPLIED VOLTAGE (V)	ANGLE	TRIPPING TIME (S)	
			THEORETICAL	ADMISSIBLE
VI	65	0º	NO TRIP	NA
VII	65	120º		
VIII	65	240º		
VI	55	0º	2	[1.9–2.1]
VII	55	240º		
VIII	55	120º		
VI	45	0º	NO TRIP	NA
VII	45	240º		
VIII	45	120º		

NOTE: All angles mentioned on the tables are delay angles, where a balanced ABC system would be composed by:

CHANNEL	APPLIED VOLTAGE (V)	ANGLE
VI	65	0º
VII	65	120º
VIII	65	240º

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

GENERAL SETTINGS	
Nominal Frequency	50 Hz

ELEMENT SETTINGS		
FREQUENCY (81)	**81U**	**81O**
Function	ENABLED	ENABLED
Pickup Level	47.50 Hz	52.50 Hz
Trip Delay	2.00 sec	2.00 sec
Reset Delay	0.00 sec	0.00 sec
Minimum Voltage	30 V	30 V

Apply voltage as indicated on the table, modifying frequency from the maximum threshold (48 Hz) to the minimum (46 Hz) for 81U, and from the minimum (52 Hz) to the maximum (54 Hz) for 81O, in steps of 10 mHz.

Verify that the relay trips at the set frequency in the corresponding element with an error of 3% ó +/-50 mHz.

Apply a voltage that is lower than the “Minimum Voltage” setting, with a frequency under (81U) or over (81O) the setting, and verify that the relay does not trip.

ELEMENTS	PHASE	PICKUP LEVEL (HZ)	TRIP DELAY (SECONDS)	APPLIED VOLTAGE (V)	FREQUENCY THRESHOLDS	TRIPPING TIME (S)	
						THEORETICAL	ADMISSIBLE
81U	VII	47.5	2	80	48 Hz	No trip	NA
					46 Hz	2	[1.9 –2.2]
				25	46 Hz	No trip	NA
81 O	VII	52.5	2	80	52 Hz	No trip	NA
					54 Hz	2	[1.9 –2.2]
				25	54 Hz	No trip	NA

Set protection element 79 as follows:

RECLOSER	
Function	ENABLED
Max Number Shots	4
Dead Time 1	2.10 sec
Dead Time 2	4.10 sec
Dead Time 3	6.10 sec
Dead Time 4	8.10 sec
Reclaim Time	3.00 sec
Cond. Permission	ENABLED
Hold Time	7.00 sec
Reset Time	5.00 sec

Set the relay to trip by 50PH

50PH SETTINGS	
Function	ENABLED
Input	RMS
Pickup Level	3 A
Trip Delay	0.00 s
Reset Delay	0.00 s

6.16.1 RECLOSING CYCLE

Connect a latching relay simulating the breaker managed by the F650 unit.

Once the relay is set, close the breaker and wait for 5 seconds.

After this time, the recloser is ready to initiate the reclosing cycle.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 2.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 4.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 6.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 8.1 seconds.

Command a 50PH trip and verify that the breaker opens and the recloser passes to Lockout.

Verify the correct operation of programmed outputs

Tripping times must be within the following values:

Reclosing Cycle		
Nº shot	Theoretical time	Admissible time
1	2.1 sec	[1.8 – 2.3]
2	4.1 sec	[3.8 – 4.3]
3	6.1 sec	[5.8 – 6.3]
4	8.1 sec	[7.8 – 8.3]

6.16.2 RECLOSER STATUSES

BLOCK

Activate the block input and verify that the recloser is in BLOCK status.

Close the breaker and wait for 5 seconds.

Command a trip and verify that the breaker opens but there is no reclose.

INHIBITION BY RECLOSING CONDITIONS

Close the breaker and wait for 5 seconds.

Command a trip, verify that the breaker opens and wait for the first shot.

Activate the inhibition input and command a new trip.

Verify that the breaker opens, wait for 8 seconds and verify that the relay does not reclose.

6.16.3 EXTERNAL RECLOSE INITIATION

Close the breaker and wait for 5 seconds.

Activate the reclose initiation input and open the breaker, verify that the relay executes the first shot

Disable all protection elements except for Thermal Model (49).

Set the pickup level to 2 A.

Set the time constant τ1 to 3 minutes and τ2 t0 one time τ1.

Apply currents of 2, 5, and 10 times the tap and ensure that the operation times are within the range described on the following table:

RATED CURRENT (A)	APPLIED CURRENT (A)	TIMES DE SET TAP	OPERATION TIME (S)
	4.0	2	48.5 - 53.6
5	10.0	5	7.06 - 7.80
	20.0	10	1.77 - 1.95

After each measure, the thermal element must be reset to zero in order to start the next test at a zero thermal status condition.

Repeat the test selecting a time constant τ1 of 60 minutes. Verify that the operation time is within the range described on the following table:

RATED CURRENT (A)	APPLIED CURRENT (A)	TIMES DE SET TAP	OPERATION TIME (S)
	4.0	2	960 - 1072
5	10.0	5	141 - 156
	20.0	10	35.4 - 39

After each measure, the thermal element must be reset to zero in order to start the next test at a zero thermal status condition.

Q1 Does the F650 support DNP and ModBus over the Ethernet port?

A1 F650 units support both protocols over both the asynchronous serial ports and the Ethernet LAN synchronous port using TCP/IP and UDP/IP layers over the Ethernet.

Q2 Does this equipment support dual IP access?

A1 Yes, it supports two independent IP addresses in aliasing mode. Those address go in the communications settings Network0 and Network1.

Q3 Is the protocol IEC 870-103 supported by the F650?

A3 At this moment it is not supported.

Q4 Can the F650 be used as a DNP master station?

A4 Not at this moment. It works as a slave IED station for all protocols.

Q5 How many communication ports are included in the F650?

A5 The equipment has 2 different boards, one for asynchronous serial ports and another for a high-speed synchronous Ethernet port. The first board has 2 comm ports, COM1 and COM2. COM2 is multiplexed with the front serial RS232 port, whereas the COM1 port is completely independent from COM2.

The synchronous LAN port is COM3.

Q6 Are there one or two Ethernet ports?

A6 The equipment has only 1 Ethernet port. For redundant fiber optic versions, redundancy is done at the physical level (fiber optic) but there is just one port.

Q7 How many different communication Ethernet sessions can be opened through the LAN port?

A7 ModBus TCP/IP:4 sockets

DNP TCP/IP:3 sessions (from version 1.72 on)

Q8 Does it support peer-to-peer horizontal communications? Is this going to interface with UR relays?

A8 It is not included in the present release.

Q9 May I use the cooper 10/100 BaseTX connection included in the basic model with all protocols?

A9 Yes, it may be used with all protocols. In noisy substation environments and/or long distances, it is recommended to use fiber optic options due to much better EMC performance and immunity. For fiber optic models, it is necessary to adjust an internal jumper to use the copper port.

Q10 Remote I/O CAN bus. Does it support DeviceNet protocol?

A10 No it does not support DeviceNet.

Q11: Which functions are available in the relay web server?

A11 Currently, it includes several functions for viewing measures and retrieving information.

Q12: What is the web site user password and name?

A12: The password is: 7169 and user name is: GE

Q13: May I use URPC to program the relay?

A13 Only oscillography records may be viewed with URPC once downloaded to a file using the ENERVISTA 650 Setup software.

Q14: May I connect URs and F650s to the same Ethernet?

A14: Yes, either in cable as in fiber, or even mix them.

Q15: How do I connect with fiber 10-BASE-FL UR relays with 100-BASE-FX F650 relays?

A15: Take into account that an UR is never connected directly to a F650 (neither two UR nor two F650 with each other) but they are always connected through a hub or switch. The hub or switch where the URs are connected must be 10-BASE-FL and the hub or switch for the F650 must be 100-BASE-FX.

Q16: How do I connect with cable 10_BASE-T UR relays with 10/100-BASE-TX F650 relays?

A16: The answer to this question is as described before but also in this case there is an advantage added, because the hub 10-BASE-TX port is able to understand a 10-BASE-T port. This means that a hub 10-BASE-T port may be connected to an UR or a F650, and a hub 10/100-BASE-TX port may be connected either to an UR or F650.

Q17: What happens with fiber optic connectors compatibility, because the hub that I have has a different connector to the one of the F650, although both are 100-BASE-FX?

A17: Just buy fiber cables with the appropriate male connectors. For the UR and F650 side we need the same connectors, ST type, for the hub side, the correspondent ones. And in what concerns to the fiber type, it is used the same for 10 as for 100, it is the 50/125 or 62.5/125 multimode, this last one allows longer distances.

Q18: What is the difference between a hub and a switch?

A18: In a repeater type hub (shared hub), one unit talks and the rest listen. If all the units are talking at the same time there may be collisions in the messages, what may produce certain communication delays.

The switch (switched hub) has very powerful processors and a lot of memory and it is much more expensive than the hub. It directs messages to the proper destination avoiding collisions and allowing a much more efficient communication.

Q19: Why do we have 10/100 compatibility for cable but not for fiber?

A19: The cable has some advantages that the fiber does not have, and it is that the signal attenuation in short and medium distances, is worthless and this is truth for low and high frequency signals. By the contrary, the light in one fiber optic is highly attenuated, being much worse in case of high frequencies than in the low ones. The 10-BASE-FL fiber transmission is performed in a wavelength of 850nm, what allows a less expensive electronic than the 1300 nm used in 100-BASE-FX fiber transmission. Using, in both cases, the same glass multimode fiber type, the attenuation to 1300 nm is lower than the 850 nm ones, this way the greater attenuation of the 100 Mbits is compensated. There is another fiber standard, the 100-BASE-SX, which uses 850 nm to 100 Mbits, being compatible with the 10-BASE-FL one, although it sacrifices the maximum distance to 300 m. Nowadays, this standard has not had success among Ethernet equipment manufacturers and suppliers.

Q1 Does the F650 support IRIG-B signals? Which type and accuracy? How many units may be connected to the same source?

A1 Yes, the F650 includes an IRIG-B input for all models, including the basic ones.

It uses DC level format B. Formats used are B0000, B0002 and B0003.

Actual accuracy is 1 millisecond. Internal sampling rate allows true 1 ms accuracy time tagging.

The input burden is very low. The maximum number of units that may be connected to a generator depends on its output driving capability. Up to 60 units have been successfully connected with equipments commonly used in the market.

Q2 Does the equipment work with dry inputs in both AC and DC?

A2 The equipment works only with DC inputs.

Inputs should be driven with externally generated DC current. No special 48 Vdc or other outputs are included in the equipment to drive these inputs; therefore, contacts connected to the equipment should be connected to a DC source.

Q3 Is this equipment valid for Petersen coil grounded systems and ungrounded systems?

A3 The 5^{th} current input is a very sensitive unit that measures from 5 mA up to 1.5 A, that is used for these systems. The present release includes 67SG (sensitive ground) as well as 67IG (isolated ground for ungrounded systems). Petersen Coil 67PC unit will be included in future releases that will only need firmware update.

Q4 Is oscillography programmable?

A4 Yes, the sampling rate is programmable (4, 8, 16, 32 or 64 samples per input). The depth will depend on the sampling rate.

Q5 Do I have to select a different model for 1 or 5 A?

A5 No. The same model is able to work with either /1 A or /5 A rated secondary currents. There are high accuracy sensing transformers that allow the use of any current input through the same terminals to reduce the spares and simplify wiring.

Q6 In my installation, several digital inputs become active when I energize the transformer. How can I reduce sensitivity?

A6 By selecting debounce time and/or voltage threshold, the relay may adapt its sensitivity to different applications. Please select the maximum voltage threshold and debounce time (recommended 15 ms) to minimize AC coupling effects.

Q1 What is the difference between Get/Send info from/to relay and Upload/Download info files to/from relay?

A1 Get/Send are used for settings and configuration storage that although both are in a unique file, are sent separately in two times. Upload/Download are used for project or PLC files group storage. These files are the setting_configuration file source. To operate, the F650 does not need the source files; the Upload/Download tool is destined to serve as historic file.

Q2 Could I program interlocks?

A2 Yes, via ENERVISTA 650 Setup interlocks may be programmed from very simple to advanced schemes.

Q3 Can we rotate the display 90 degrees to show feeders vertically?

A3 No. The product has been designed to view it in horizontal mode (landscape) due to the following reasons:

It is easier to read the LCD display because it has been designed for horizontal positions.

Compatibility between text display (4x20 characters) and LCD display (16x40 characters or 128x240 pixels).

Refresh speed is better in horizontal than vertical format.

Q4 Do I need a laptop or handheld to program the unit?

A4 No, all main operations can easily be performed with just the incorporated HMI. Handheld or laptops may be required to download large quantities of information (such as oscillograms, etc.) but they are not mandatory for a conventional user that just needs to change settings, view measurements, states, etc.

Q5 Is there password security for protection and control?

A5 Yes, there are two passwords. An independent password for protection changes and control operations is available since version 1.44.

Q6 Is it possible to have a remote HMI installed in the front of the panel with the rest of the relay in the rear side?

A6 Not in the present version.

Q7 Is it possible to program a default screen for the HMI?

A7 In graphic display versions the user may program a custom screen with the single-line diagram, measurements, etc. In text display models, there is a choice of logo, measurements, or scrolling both screens.

Q8 May I force inputs and outputs to ease commissioning and testing?

A8 Yes.

Q9 How can I disable the rotary knob buzzer?

A9 Press ESC key during more than 3 seconds and then press the knob during a short pulse.

Q10 Why do appear strange texts on the display when switching on the relay?

A10 You will have pressed any button and the HMI has entered in a test mode.

The display messages are updated after a few minutes, once the relay has completed the starting sequence.

Q1 Does the "Service" contact on the Power Supply board cover all possible failures or do I have to create an output on the I/O board that includes all the internal errors I can access in the logic?

A1 The power supply ready contact only monitor hardware failures in the power supply, to monitor the internal error of the unit it is necessary to configure a virtual output to and the assign it to the device desired (contact output, LED, etc.).

Q2 I set an output contact as "Latched". If I do not set a "reset" condition, will it reset from the "ESC" key?

A2 No, you have to configure the contact output reset signal (in ***Settings>Relay Configuration>Outputs***). The ESC key only reset the LED indicators.

7

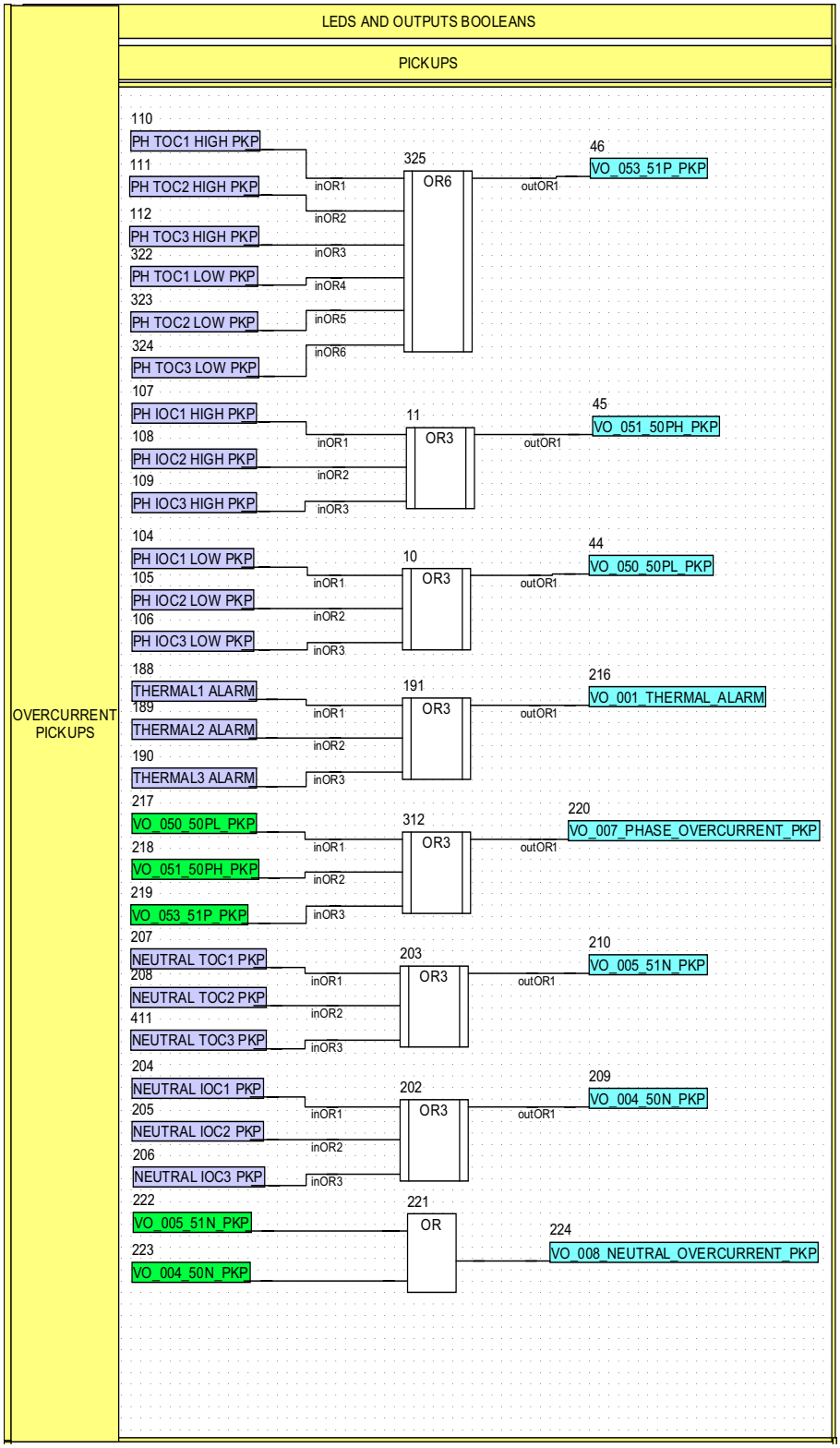
F650 units have been designed and verified using the most advanced and reliable equipment. Mounting and testing automation ensure a high consistency of the final product. Before sending a unit back to the factory, we strongly recommend you follow the recommendations below. Even if it will not always solve the problem, at least they will help define it better for a quicker repair.

If you need to send a unit back to the factory for repair, please use the appropriate RETURN MATERIAL AUTHORISATION process, and follow the shipping instructions provided by our Service Department, especially in the case of international shipments. This will lead to a faster and efficient solution of your problem.

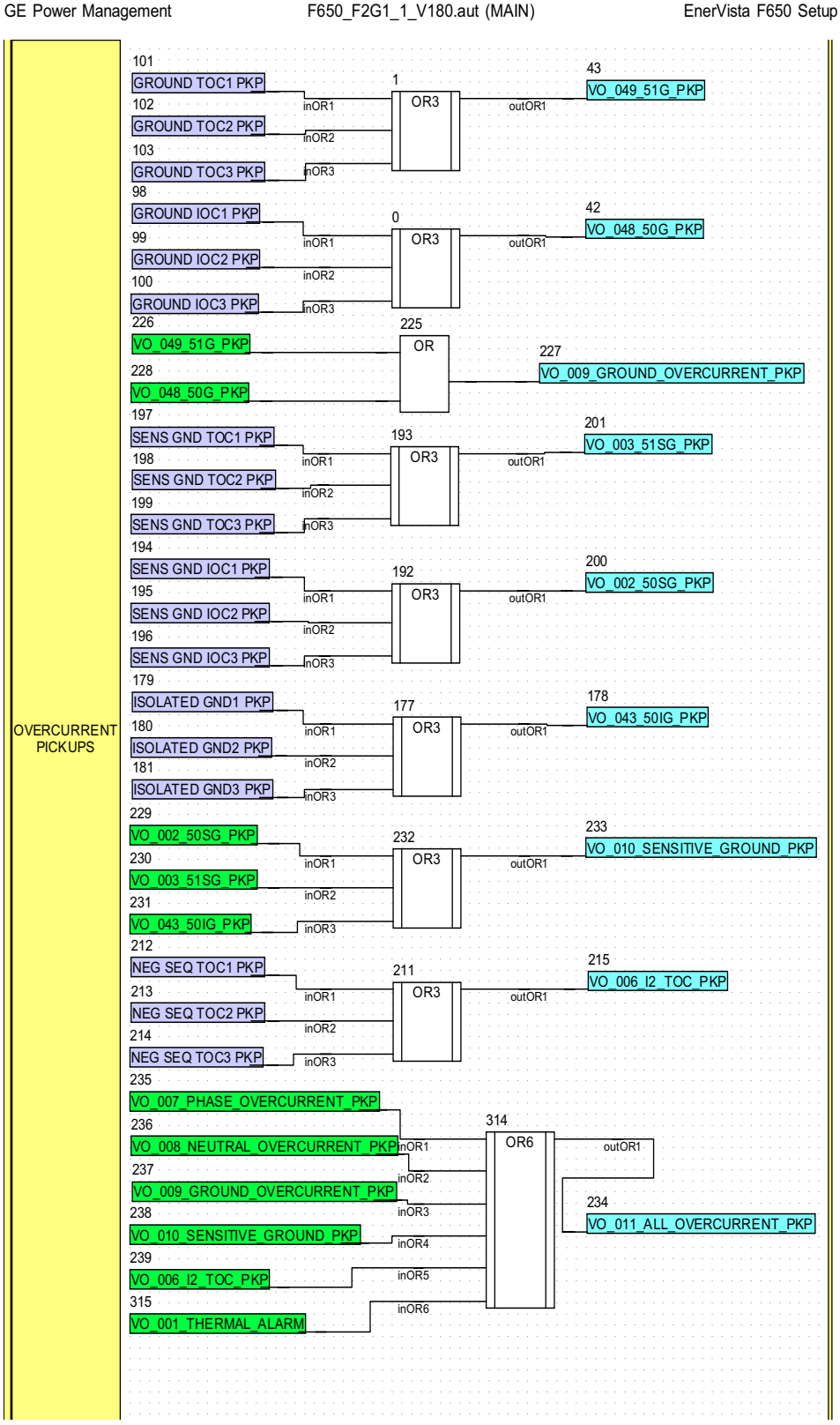
CATEGORY	SYMPTOM	POSSIBLE CAUSE	RECOMMENDED ACTION
Protection	The relay does not trip	-Function not permitted	- Set the function permission to ENABLED
		- Function blocked	- Check Protection units block screen
		- Output not assigned	- Program the output to the desired function using ENERVISTA 650 Setup logic configuration
General	When feeding the unit, no indicator is lit up	-Insufficient power supply	-Verify the voltage level using a multimeter in the power supply terminals, and check that it is within the model range
		- Wrong versions	- Check relay and ENERVISTA 650 Setup versions are the same
		-Fused fuse	-Remove power supply, dismount the power supply module and replace the fuse
		- Loose fuse	- Same as above with same fuse
		-Incorrect wiring	-Make sure that terminals labeled + and – are connected to the 9-pin connector corresponding to the power source
Communication	The relay does not communicate via the front RS232 port	-Incorrect cable	-Make sure you are using a straight cable
		-Damaged cable	-Replace the cable
		-Relay or PC not grounded	-Ensure ground connection
		-Incorrect baudrate, port, address, etc.	-Test other ports, other baudrates, etc. Make sure that the communication parameters in the computer match the ones in the relay.
General	After Updating the firmware the relay does not start up and always shows the message “Os Loading…”.	Check that the bootware version match with the firmware version	If there is an incompatibility between boot and firmware version, update to the corresponding boot and after that update the firmware version If the boot and firmware versions are correct, perform the firmware update procedure again.
Communications	Cannot see properly the web server in F650 with Windows XP. Some windows are in grey with a red cross mark.	Disabled Java options in Advanced Internet Explorer properties or high level of security	1.- Go to Advanced in Internet options for Internet explorer and select the three selections in Microsoft VM (Java Virtual Machine) and deselect any other virtual machine not Microsoft, for example SUN. In case Microsoft VM is not installed in the computer, the user must install it using the Microsoft VM installation program **msjavx86.exe** For internet explorer 6.0 or higher it is not included by default. 2.- Try to set a lower level of security in internet explorer options. 3.-Delete temporary internet files in “General” screen in internet explorer options.

Communication	Enervista 650 Setup does not retrieve osc, fault reports and Data Logger files	Bad communication in TFTP using Windows 2000	Disable and Enable the Ethernet connection on Control Panel inside Windows 2000. Try again to retrieve files from relay

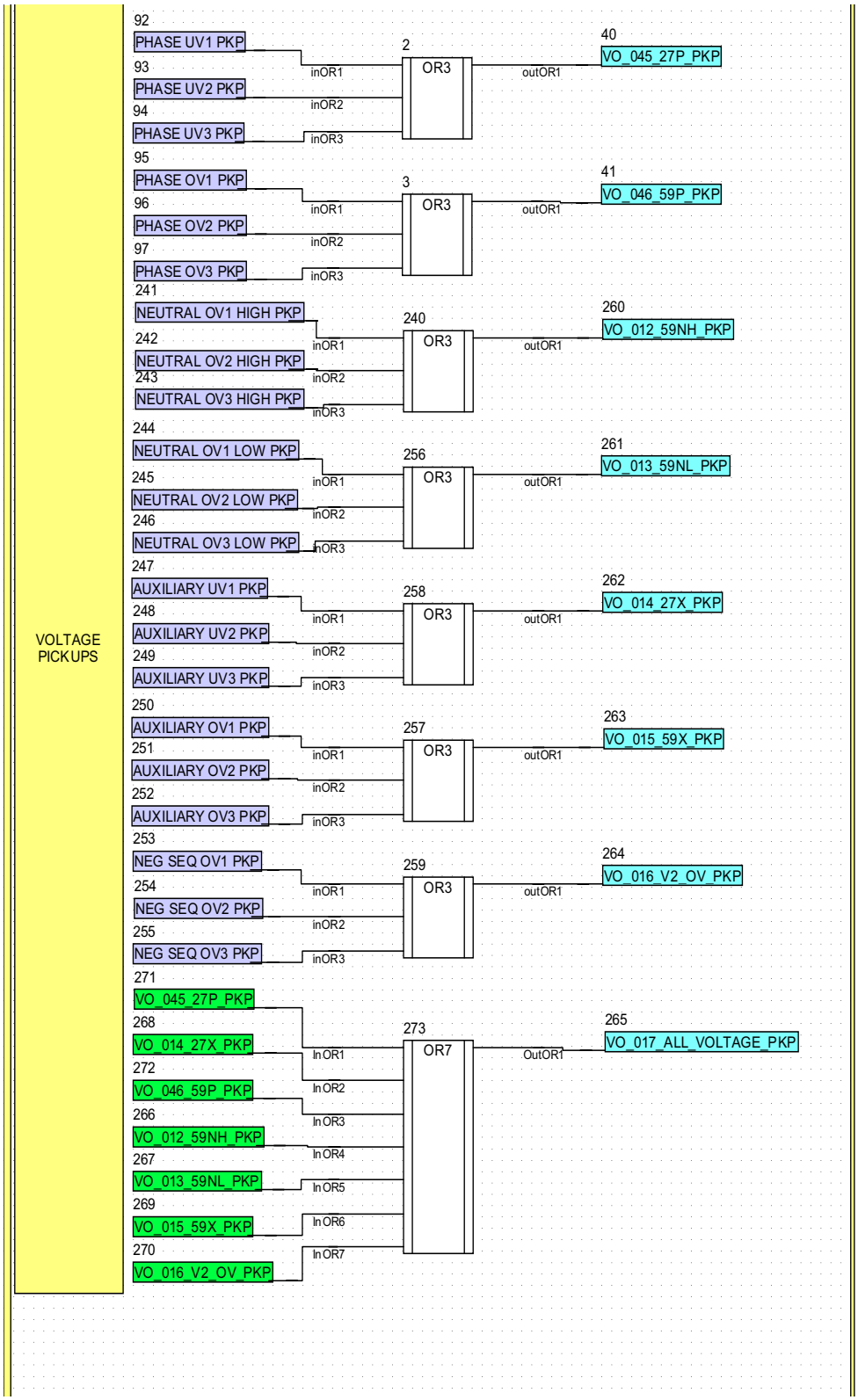
GE Power Management F650_F2G1_1_V180.aut (MAIN) EnerVista F650 Setup



A


GE Power Management
F650_F2G1_1_V180.aut (MAIN)
EnerVista F650 Setup
OVERCURRENT PICKUPS
101
GROUND TOC1 PKP
102
GROUND TOC2 PKP
103
GROUND TOC3 PKP
inOR1
inOR2
inOR3
1
OR3
outOR1
43
VO_049_51G_PKP
98
GROUND IOC1 PKP
99
GROUND IOC2 PKP
100
GROUND IOC3 PKP
0
OR3
42
VO_048_50G_PKP
226
VO_049_51G_PKP
228
VO_048_50G_PKP
225
OR
227
VO_009_GROUND_OVERCURRENT_PKP
197
SENS GND TOC1 PKP
198
SENS GND TOC2 PKP
199
SENS GND TOC3 PKP
193
OR3
201
VO_003_51SG_PKP
194
SENS GND IOC1 PKP
195
SENS GND IOC2 PKP
196
SENS GND IOC3 PKP
192
OR3
200
VO_002_50SG_PKP
179
ISOLATED GND1 PKP
180
ISOLATED GND2 PKP
181
ISOLATED GND3 PKP
177
OR3
178
VO_043_50IG_PKP
229
VO_002_50SG_PKP
230
VO_003_51SG_PKP
231
VO_043_50IG_PKP
232
OR3
233
VO_010_SENSITIVE_GROUND_PKP
212
NEG SEQ TOC1 PKP
213
NEG SEQ TOC2 PKP
214
NEG SEQ TOC3 PKP
211
OR3
215
VO_006_I2_TOC_PKP
235
VO_007_PHASE_OVERCURRENT_PKP
236
VO_008_NEUTRAL_OVERCURRENT_PKP
237
VO_009_GROUND_OVERCURRENT_PKP
238
VO_010_SENSITIVE_GROUND_PKP
239
VO_006_I2_TOC_PKP
315
VO_001_THERMAL_ALARM
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
314
OR6
outOR1
234
VO_011_ALL_OVERCURRENT_PKP

GE Power Management F650_F2G1_1_V180.aut (MAIN) EnerVista F650 Setup



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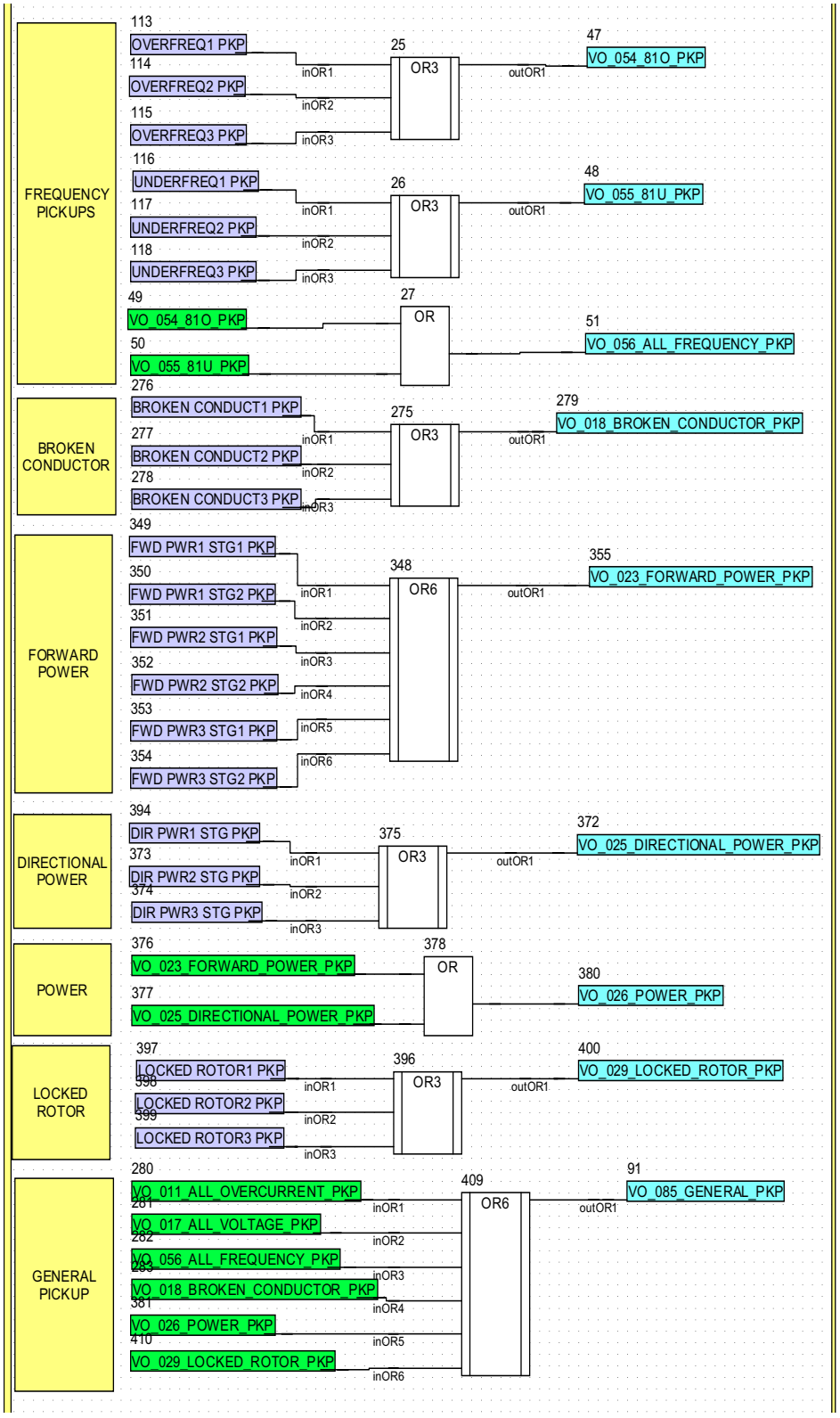
GE Power Management F650_F2G1_1_V180.aut (MAIN) EnerVista F650 Setup



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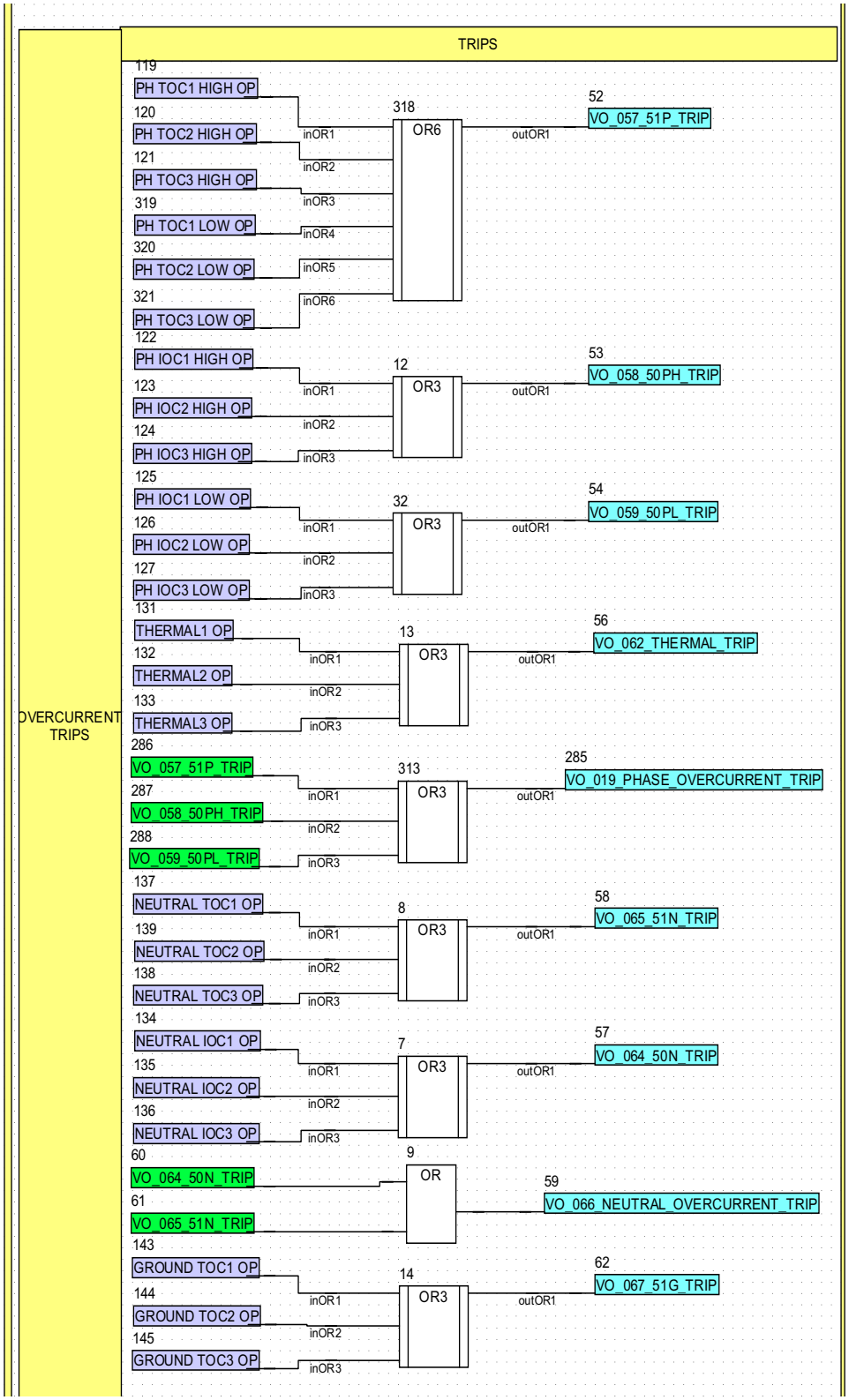
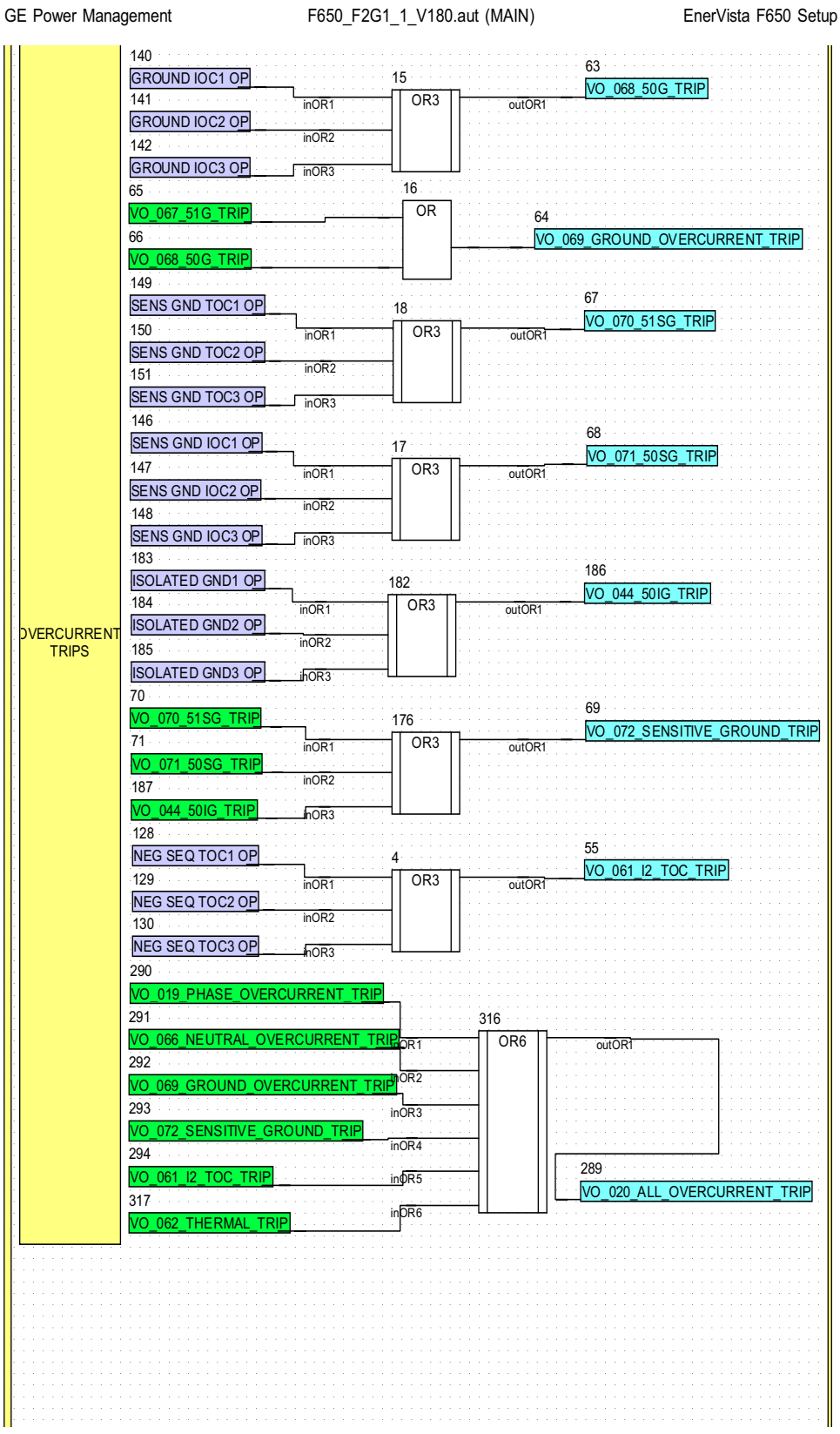
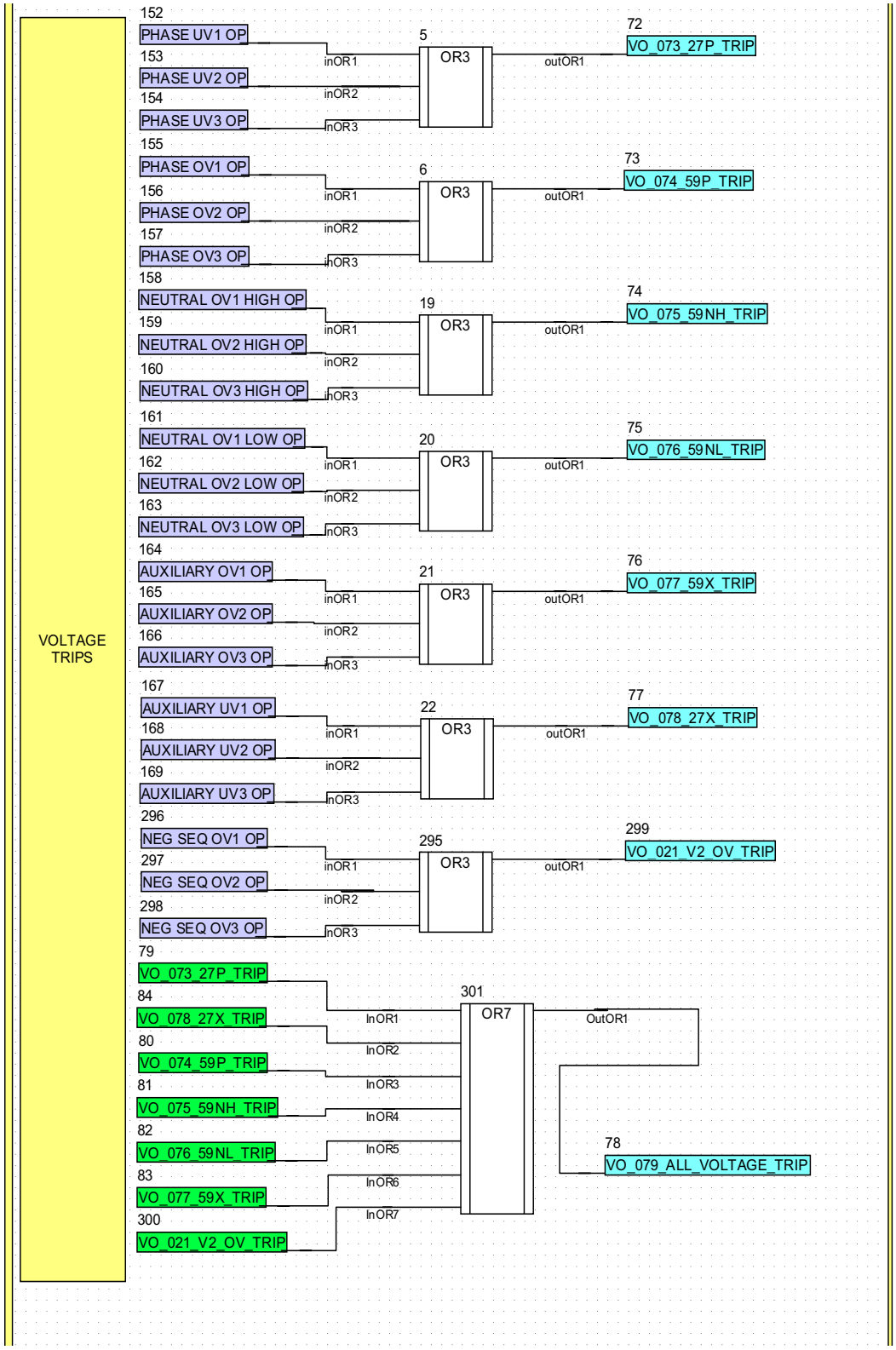
GE Power Management F650_F2G1_1_V180.aut (MAIN) EnerVista F650 Setup




GE Power Management
F650_F2G1_1_V180.aut (MAIN)
EnerVista F650 Setup
OVERCURRENT TRIPS
140
GROUND IOC1 OP
141
GROUND IOC2 OP
142
GROUND IOC3 OP
15
OR3
inOR1
inOR2
inOR3
outOR1
63
VO_068_50G_TRIP
65
VO_067_51G_TRIP
66
VO_068_50G_TRIP
16
OR
64
VO_069_GROUND_OVERCURRENT_TRIP
149
SENS GND TOC1 OP
150
SENS GND TOC2 OP
151
SENS GND TOC3 OP
18
OR3
67
VO_070_51SG_TRIP
146
SENS GND IOC1 OP
147
SENS GND IOC2 OP
148
SENS GND IOC3 OP
17
OR3
68
VO_071_50SG_TRIP
183
ISOLATED GND1 OP
184
ISOLATED GND2 OP
185
ISOLATED GND3 OP
182
OR3
186
VO_044_50IG_TRIP
70
VO_070_51SG_TRIP
71
VO_071_50SG_TRIP
187
VO_044_50IG_TRIP
176
OR3
69
VO_072_SENSITIVE_GROUND_TRIP
128
NEG SEQ TOC1 OP
129
NEG SEQ TOC2 OP
130
NEG SEQ TOC3 OP
4
OR3
55
VO_061_I2_TOC_TRIP
290
VO_019_PHASE_OVERCURRENT_TRIP
291
VO_066_NEUTRAL_OVERCURRENT_TRIP
292
VO_069_GROUND_OVERCURRENT_TRIP
293
VO_072_SENSITIVE_GROUND_TRIP
294
VO_061_I2_TOC_TRIP
317
VO_062_THERMAL_TRIP
316
OR6
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
outOR1
289
VO_020_ALL_OVERCURRENT_TRIP

GE Power Management F650_F2G1_1_V180.aut (MAIN) EnerVista F650 Setup



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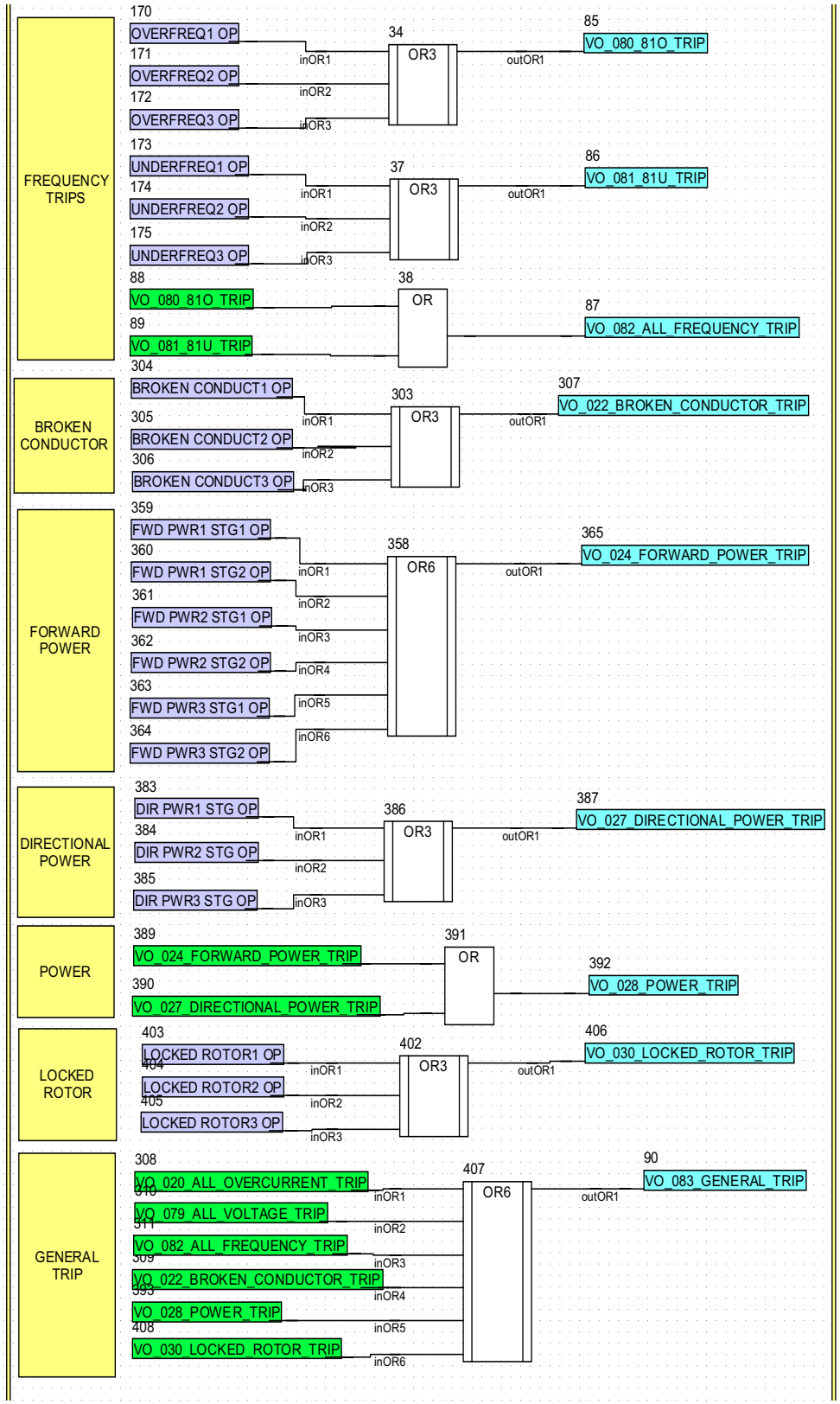
GE Power Management F650_F2G1_1_V180.aut (MAIN) EnerVista F650 Setup



B.1.1 FACTORY DEFAULT SETTINGS

PRODUCT SETUP>COMMUNICATION SETTINGS >SERIAL PORTS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Baud rate for COM 1	COM1 Baud Rate	19200	N/A	[300 : 115200]	
Baud rate for COM 2	COM2 Baud Rate	19200	N/A	[300 : 115200]	
Parity for serial COM ports	Parity	NONE	N/A	[NONE:ODD:EVEN]	

PRODUCT SETUP>COMMUNICATION SETTINGS >NETWORK (ETHERNET)					
NETWORK (ETHERNET)1 > NETWORK (ETHERNET)2					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
1st octec of IP address	IP Address Oct1	0	N/A	[0 : 255]	
2nd octec of IP address	IP Address Oct2	0	N/A	[0 : 255]	
3rd octec of IP address	IP Address Oct3	0	N/A	[0 : 255]	
4th octec of IP address	IP Address Oct4	0	N/A	[0 : 255]	
1st octec of Netmask	Netmask Oct1	0	N/A	[0 : 255]	
2nd octec of Netmask	Netmask Oct2	0	N/A	[0 : 255]	
3rd octec of Netmask	Netmask Oct3	0	N/A	[0 : 255]	
4th octec of Netmask	Netmask Oct4	0	N/A	[0 : 255]	
1st octec of Gateway	Gateway IP Oct1	0	N/A	[0 : 255]	
2nd octec of Gateway	Gateway IP Oct2	0	N/A	[0 : 255]	
3rd octec of Gateway	Gateway IP Oct3	0	N/A	[0 : 255]	
4th octec of Gateway	Gateway IP Oct4	0	N/A	[0 : 255]	

PRODUCT SETUP>COMMUNICATION SETTINGS >MODBUS PROTOCOL					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Slave address for COM1	Modbus Address COM1	254	N/A	[1 : 255]	
Slave address for COM2	Modbus Address COM2	254	N/A	[1 : 255]	
Modbus port number for Modbus TCP/IP	Modbus Port Number	502	N/A	[0 : 65535]	

PRODUCT SETUP>COMMUNICATION SETTINGS >DNP3 SLAVE					
DNP3 SLAVE 1 > DNP3 SLAVE 2 > DNP3 SLAVE 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Communications port assigned to the DNP protocol	Physical Port	NONE	N/A	[COM1:COM2:NETWORK]	
DNP slave address	Address	255	N/A	[0 : 65534]	
1st Octect of IP address of DNP master 1	IP Addr Client1 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 1	IP Addr Client1 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 1	IP Addr Client1 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 1	IP Addr Client1 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 2	IP Addr Client2 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 2	IP Addr Client2 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 2	IP Addr Client2 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 2	IP Addr Client2 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 3	IP Addr Client3 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 3	IP Addr Client3 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 3	IP Addr Client3 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 3	IP Addr Client3 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client4 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client4 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client4 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client4 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client5 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client5 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client5 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client5 Oct4	0	N/A	[0 : 255]	
TCP/UDP port number for DNP over Ethernet	TCP/UDP Port	20000	N/A	[0 : 65535]	
Unsolicited responses permission	Unsol Resp Function	DISABLED	N/A	[DISABLED – ENABLED]	
Time out to confirm an unsolicited response	Unsol Resp TimeOut	5	1 s	[0 : 60]	
Number of retransmition of an unsol resp w/o confirmation	Unsol Resp Max Ret	10	N/A	[0 : 255]	
Address to which all unsolicited responses are sent	Unsol Resp Dest Adr	200	N/A	[0 : 65519]	
Scale for currents	Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for voltages	Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	

PRODUCT SETUP>COMMUNICATION SETTINGS >DNP3 SLAVE (CONT.)					
DNP3 SLAVE 1 > DNP3 SLAVE 2 > DNP3 SLAVE 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Scale for power	Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for energy	Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Other Scale factor	Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Default deadband for Current Analog Input points to trigger unsolicited responses	Current Deadband	30000	N/A	[0 : 65535]	
Default deadband for Voltage Analog Input points to trigger unsolicited responses	Voltage Deadband	30000	N/A	[0 : 65535]	
Default deadband for Power Analog Input points to trigger unsolicited responses	Power Deadband	30000	N/A	[0 : 65535]	
Default deadband for Energy Analog Input points to trigger unsolicited responses	Energy Deadband	30000	N/A	[0 : 65535]	
Default deadband for Other Analog Input points to trigger unsolicited responses	Other Deadband	30000	N/A	[0 : 65535]	
Size (in bytes) for message fragmentation	Msg Fragment Size	240	1 byte	[30 : 2048]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 1	CTL EVENTS 1-16	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 2	CTL EVENTS 17-32	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 3	CTL EVENTS 33-48	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 4	CTL EVENTS 49-64	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 5	CTL EVENTS 65-80	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 6	CTL EVENTS 81-96	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 7	CTL EVENTS 97-112	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 8	CTL EVENTS 113-128	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 9	SWITCHGEAR 1-8	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 10	SWITCHGEAR 9-16	N/A	[See DNP note2]	

DNP NOTES	
Note 1: Scale Factor	Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value will be 10 times
Note 2: Binary Input Block Selection:	[NOT USED, CTL EVENTS 1-16, CTL EVENTS 17-32, CTL EVENTS 33-48,CTL EVENTS 49-64, CTL EVENTS 65-80, CTL EVENTS 81-96, CTL EVENTS 97-112, CTL EVENTS 113-128, SWITCHGEAR 1-8, SWITCHGEAR 9-16]

PRODUCT SETUP>COMMUNICATION SETTINGS >IEC 870-5-104					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Enable or disable the protocol operation	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Listening TCP port in the relay	TCP Port	2404	N/A	[0 : 65535]	
Address in the ASDU header	Common Addr of ASDU	255	N/A	[0 : 65535]	
Number of seconds for instantaneous meterings	Cyclic Meter Period	0	1 s	[0 : 3600]	
Not implemented	Synchronization Event	0	N/A	[0 : 3600]	

IEC 870-5-104 NOTES	
Note 1: Cyclic Meter Period	0 value means no spontaneous meterings

SETPOINT > PRODUCT SETUP > FAULT REPORT					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Positive sequence impedance module	Pos Seq Module	3.00	0.01 Ohm	[0.01 : 250.00]	
Positive sequence impedance angle	Pos Seq Angle	75	1 Deg	[25 : 90]	
Zero sequence impedance module	Zero Seq Module	9.00	0.01 Ohm	[0.01 : 750.00]	
Zero sequence impedance angle	Zero Seq Angle	75	1 Deg	[25 : 90]	
Line length	Line Length	100.0	0.1	[0.0 : 2000.0]	
Display fault on HMI	Show Fault On HMI	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

PRODUCT SETUP > MODBUS USER MAP					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Address 00 for Modbus user map	Address 00	0	N/A	[0000 : FFFF]	
Address 01 for Modbus user map	Address 01	0	N/A	[0000 : FFFF]	
	...	...		...	
Address 254 for Modbus user map	Address 254	0	N/A	[0000 : FFFF]	
Address 255 for Modbus user map	Address 255	0	N/A	[0000 : FFFF]	

SETPOINT > PRODUCT SETUP > OSCILLOGRAPHY					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function Permission	Function	ENABLED	N/A	[DISABLED – ENABLED]	
Prefault	Trigger Position	30	1%	[5 : 95]	
Samples per cycle	Samples/Cycle	64	N/A	[4 – 8 – 16 –32 – 64]	
Maximum number of oscillos	Max. Number Osc.	4	1 oscillo	[1 : 20]	
Automatic oscillography overwrite	Automatic Overwrite	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PRODUCT SETUP > DATA LOGGER					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Data logger Rate	Data Logger Rate	1 s	N/A	[1 s, 5 min, 10 min, 15 min, 20 min, 30 min, 60 min.]	
Data Logger analog channels X	Data Logger Chnl X	None	N/A		

SETPOINT > PRODUCT SETUP > DEMAND					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Demand Function	DISABLED	N/A	[DISABLED – ENABLED]	
Demand method for current values	CRNT Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand method for Power values	POWER Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand interval	Demand Interval	5 Minutes	N/A	[5 – 10 – 15 – 20– 30–60]	
Trigger Enabled	Trigger Enabled	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > SYSTEM SETUP > GENERAL SETTINGS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Phase CT ratio	Phase CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Ground CT ratio	Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Sensitive ground CT ratio	Stv Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT ratio	Phase VT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT connection	Phase VT Connection	WYE	N/A	[WYE – DELTA]	
Rated voltage	Nominal Voltage	100.0	0.1	[1.0 : 250.0]	
Rated Frequency	Nominal Frequency	50 Hz	Hz	[50-60]	
Phase rotation	Phase Rotation	ABC	N/A	[ABC – ACB]	
Frequency reference	Frequency Reference	VI	N/A	[VI-VII-VIII]	
Auxiliary Voltage	Auxiliary Voltage	VX	N/A	[VX – VN]	
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > SYSTEM SETUP > FLEX CURVES					
FLEX CURVES A > FLEX CURVES B> FLEX CURVES C > FLEX CURVES D					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Values for reset points 0.00 pkp	Time 0.00xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.05 pkp	Time 0.05xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
…	…	…	0.001 s	[0.000 : 65.535]	
Values for reset points 0.97 pkp	Time 0.97xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.98 pkp	Time 0.98xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.03 pkp	Time 1.03xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.05 pkp	Time 1.05xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
…	…	…	0.001 s	[0.000 : 65.535]	
Values for operation points 19.50 pkp	Time 19.50xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 20.00 pkp	Time 20.00xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER SETTINGS					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Number of Switchgear selected as breaker	Number of Switchgear	1	1	[1 : 16]	
Maximum value of KI2t	Maximum KI2t	9999.99	0.01(KA)2 s	[0.00 : 9999.99]	
KI2t integration time	KI2t Integ. Time	0.03	0.01s	[0.03 : 0.25]	
Maximum number of openings	Maximum Openings	9999	1	[0 : 9999]	
Maximum Openings in one hour	Max.Openings 1 hour	40	1	[1 : 60]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > SYSTEM SETUP > BREAKER > BREAKER MAINTENANCE					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
KI2t Counter Phase A	KI2t BKR Ph A Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
KI2t Counter Phase B	KI2t BKR Ph B Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
KI2t Counter Phase C	KI2t BKR Ph C Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
Openings counter	BKR Openings Cnt	0	1	[0 : 9999]	
Closings counter	BKR Closings Cnt	0	1	[0 : 9999]	

SETPOINT > SYSTEM SETUP > SWITCHGEAR					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Snapshot Event generation for switchgear #1	Snapshot Events SWGR 1	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #2	Snapshot Events SWGR 2	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #3	Snapshot Events SWGR 3	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #4	Snapshot Events SWGR 4	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #5	Snapshot Events SWGR 5	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #6	Snapshot Events SWGR 6	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #7	Snapshot Events SWGR 7	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #8	Snapshot Events SWGR 8	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #9	Snapshot Events SWGR 9	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #10	Snapshot Events SWGR 10	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #11	Snapshot Events SWGR 11	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #12	Snapshot Events SWGR 12	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #13	Snapshot Events SWGR 13	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #14	Snapshot Events SWGR 14	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #15	Snapshot Events SWGR 15	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #16	Snapshot Events SWGR 16	DISABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT >					
> PHASE TOC HIGH > PHASE TOC HIGH 1> PHASE TOC HIGH 2 > PHASE TOC HIGH 3					
> PHASE TOC LOW > PHASE TOC LOW 1 > PHASE TOC LOW 2 > PHASE TOC LOW 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Voltage Restraint	Voltage Restraint	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT >					
> PHASE IOC HIGH > PHASE IOC HIGH 1> PHASE IOC HIGH 2 > PHASE IOC HIGH 3					
> PHASE IOC LOW > PHASE IOC LOW 1 > PHASE IOC LOW 2 > PHASE IOC LOW 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[Phasor – RMS]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > PHASE DIRECTIONAL >					
PHASE DIRECTIONAL 1> PHASE DIRECTIONAL 2 > PHASE DIRECTIONAL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	40	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > PHASE CURRENT > THERMAL MODEL >					
THERMAL MODEL 1> THERMAL MODEL 2 > THERMAL MODEL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Heating constant	Heat Time Constant	6.0	0.1 min	[3.0 : 600.0]	
Cooling constant	Cool Time Constant	2.00	0.01 times Heat Time Ct.	[1.00 : 6.00]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Alarm level	Alarm Level	80.0	0.10%	[1.0 : 110.0]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL TOC					
NEUTRAL TOC 1> NEUTRAL TOC 2 > NEUTRAL TOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL IOC					
NEUTRAL IOC 1> NEUTRAL IOC 2 > NEUTRAL IOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEUTRAL CURRENT > NEUTRAL DIRECTIONAL >					
NEUTRAL DIRECTIONAL 1> NEUTRAL DIRECTIONAL 2 > NEUTRAL DIRECTIONAL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND TOC					
GROUND TOC 1> GROUND TOC 2 > GROUND TOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND IOC					
GROUND IOC 1> GROUND IOC 2 > GROUND IOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > GROUND CURRENT > GROUND DIRECTIONAL >					
GROUND DIRECTIONAL 1> GROUND DIRECTIONAL 2 > GROUND DIRECTIONAL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND TOC					
SENSITIVE GROUND TOC 1> SENSITIVE GROUND TOC 2 > SENSITIVE GROUND TOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.050	0.001 A	[0.005 : 16.000]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND IOC					
SENSITIVE GROUND IOC 1> SENSITIVE GROUND IOC 2 > SENSITIVE GROUND IOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.100	0.001 A	[0.005 : 16.000]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > ISOLATED GROUND IOC					
ISOLATED GROUND IOC 1> ISOLATED GROUND IOC 2 > ISOLATED GROUND IOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
High Voltage level	Vh Level	20	1 V	[2 : 70]	
Low Current level	Il LEVEL	0.005	0.001 A	[0.005 : 0.400]	
Low Voltage level	Vl LEVEL	2	1 V	[2 : 70]	
High Current level	Ih LEVEL	0.025	0.001 A	[0.005 : 0.400]	
Operation time	Delay	0.00	0.01 s	[0.00 : 900.00]	
Deviation time to instantaneous	Time to inst	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
SETPOINT > PROTECTION ELEMENTS > SENSITIVE GROUND CURRENT > SENSITIVE GROUND DIRECTIONAL >					
SENSITIVE GROUND DIRECTIONAL 1> SENSITIVE GROUND DIRECTIONAL 2 > SENSITIVE GROUND DIRECTIONAL 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE CURRENT > NEGATIVE SEQUENCE TOC >					
NEGATIVE SEQUENCE TOC 1> NEGATIVE SEQUENCE TOC 2 > NEGATIVE SEQUENCE TOC 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE UV > PHASE UV 1> PHASE UV 2 > PHASE UV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input mode	Mode	PHASE-PHASE	N/A	[PHASE-PHASE, PHASE-GROUND]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Minimum Voltage Threshold	Minimum Voltage	5	1 V	[0 : 300]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Supervision by breaker status	Supervised by 52	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > PHASE OV > PHASE OV 1> PHASE OV 2 > PHASE OV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > VOLTAGE ELEMENTS > >NEUTRAL OV HIGH > NEUTRAL OV HIGH 1> NEUTRAL OV HIGH 2 > NEUTRAL OV HIGH 3 >NEUTRAL OV LOW > NEUTRAL OV LOW 1> NEUTRAL OV LOW 2 > NEUTRAL OV LOW 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > NEGATIVE SEQUENCE OV >					
NEGATIVE SEQUENCE OV 1> NEGATIVE SEQUENCE OV 2 > NEGATIVE SEQUENCE OV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > AUXILIARY UV >					
AUXILIARY UV 1> AUXILIARY UV 2 > AUXILIARY UV 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > POWER > FORWARD POWER					
FORWARD POWER 1> FORWARD POWER 2 > FORWARD POWER 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from off-line	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > PROTECTION ELEMENTS > POWER > DIRECTIONAL POWER>					
DIRECTIONAL POWER 1> DIRECTIONAL POWER 2 > DIRECTIONAL POWER 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from off-line	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 1	Dir Power Angle 1	0.00	1 Deg	[0.00 : 359.99]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[-10000.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 2	Dir Power Angle 2	0.00	1 Deg	[0.00 : 359.99]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[-10000.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > SETTING GROUP					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > UNDERFREQUENCY					
UNDERFREQUENCY 1 > UNDERFREQUENCY 2 > UNDERFREQUENCY 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	49.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	30	1 V	[30 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > OVERFREQUENCY					
OVERFREQUENCY 1 > OVERFREQUENCY 2 > OVERFREQUENCY 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	50.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	30	1 V	[30 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > SYNCHROCHECK					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead bus voltage level	Dead Bus Level	10.00	0.01 V	[0.00 : 300.00]	
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 300.00]	
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 300.00]	
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 300.00]	
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 300.00]	
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]	
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]	
Breaker Closing time	Time	0.50	0.01 s	[0.01 : 600.00]	
Dead Line – Dead Bus Function permission	DL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Live Line – Dead Bus Function permission	LL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead Line – Live Bus Function permission	DL-LB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > AUTORECLOSE					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Number of shots	Max Number Shots	1	N/A	[1 : 4]	
Dead time 1	Dead Time 1	0.00	0.01 s	[0.00 : 900.00]	
Dead time 2	Dead Time 2	0.00	0.01 s	[0.00 : 900.00]	
Dead time 3	Dead Time 3	0.00	0.01 s	[0.00 : 900.00]	
Dead time 4	Dead Time 4	0.00	0.01 s	[0.00 : 900.00]	
Reclaim time or reset lockout delay	Reclaim Time	0.00	0.01 s	[0.00 : 900.00]	
Reclose conditions permission	Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]	
Hold time	Hold Time	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Time	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > VT FUSE FAILURE					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > LOCKED ROTOR BROKEN CONDUCTOR 1 >BROKEN CONDUCTOR 2 >BROKEN CONDUCTOR 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Tap Level in percentage of I2/I1	Tap	20	0.10%	[20.0 : 100.0]	
Trip Time	Trip Delay	60	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Current Inhibition Level setting	Operation Threshold	0.005	0.001 A	[0.000 : 1.000]	

SETPOINT > CONTROL ELEMENTS > LOCKED ROTOR LOCKED ROTOR 1 >LOCKED ROTOR 2 >LOCKED ROTOR 3					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Full load current	Full Load Current	0.5	KA	[0.10 : 10.00]	
Pickup level	Pickup Level	1.01	N/A	[1.01 : 109.00]	
Trip time	Trip Delay	0	s	[0.00 : 900.00]	
Reset time	Reset Delay	0	s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > INPUTS/OUTPUTS > CONTACT I/O > BOARD F > BOARD G > BOARD H > BOARD J					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
I/O board type (available only for CIO modules)	I/O Board Type_H	NONE	N/A	[NONE, 16 INP + 8OUT, 8 INP + 8OUT + SUPV]	
Input activation voltage threshold Group A	Voltage Threshold A_**X**	80	1 V	[0 : 255]	
Input activation voltage threshold Group B	Voltage Threshold B_**X**	80	1 V	[0 : 255]	
Debounce time for Group A	Debounce Time A_**X**	15	1 ms	[1 : 50]	
Debounce time for Group B	Debounce Time B_**X**	15	1 ms	[1 : 50]	
Input type	Input Type_**X**_CC**Y** (CC**Y**)	POSITIVE	N/A	[POSITIVE-EDGE, NEGATIVE-EDGE, POSITIVE, NEGATIVE]	
Input signal time delay	Delay Input Time_**X**_CC**Y** (CC**Y**)	0	1 ms	[0 : 60000]	
Output logic type	Output Logic_**X**_0**Z**	POSITIVE	N/A	[POSITIVE, NEGATIVE]	
Output type	Output Type_**X**_0**Z**	NORMAL	N/A	[NORMAL, PULSE, LATCH]	
Output pulse length	Pulse Output Time_**X**_0**Z**	10000	1 ms	[0 : 60000]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

NOTE 2: DESCRIPTION OF X, Y AND Z IN INPUT/OUTPUT BOARDS			
X	F, G, H or J, the I/O board name, depending on the Relay model.		
	F and G are internal Relay boards, and H and J are additional boards available in CIO modules (remote Bus CAN I/O module).		
For the I/O board selection in the relay model:	I/O BOARD TYPE		
	ASSOCIATED DIGIT	ENERVISTA 650 SETUP BOARD SETTINGS	BOARD TYPE
	0	NONE	None
	1	16 INP+ 8OUT	Mixed
	2	8 INP +8 OUT +SUPV	Supervision

CC**Y**	Is the name used for inputs in I/O boards
	Mixed, 16 digital inputs: CC1….CC16
	Supervision: 8 digital inputs: CC1,..., CC8
0**Z**	Is the name used for the different outputs in I/O boards, 8 outputs available for any of the two types of board (01,…., 08)

LIST OF TIME OVERCURRENT CURVES AVAILABLE IN F650
IEEE extremely/very/moderately inverse
IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse
IAC extremely/very/normally/moderately inverse
ANSI extremely/very/normally/moderately inverse
I2t
Definite time
Rectifier curve
User Curve - FlexCurve™ A/B/C/D

NOTE:

SOURCE COLUMN:

This columns allow selecting the simple or complex (OR signal or Virtual output) operand that actives the selected elements on relay configuration

If more than one operands are selected, the relay performs an OR gate with them to activate the selected element.

SIGNAL LOGIC COLUMN:

Refers to each individual signal selected on its left. NOT legend means that the refered signal is inverted

SOURCE LOGIC COLUMN:

Refers to the whole SOURCE signal selected on its left. NOT legend means that SOURCE signal is inverted

If more than one operand were selected, the OR gate output is inverted

SETPOINT>RELAY CONFIGURATION>OUTPUTS				
OUTPUT ID	**OUTPUT NAME**	**SOURCE**	**SIGNAL LOGIC**	**SOURCE LOGIC**
CONT OP OPER_F_01	79 BLOCKED	AR BLOCK BY LEVEL		
CONT OP OPER_F_02	27/59 PKP	VO_046_59P_PKP		
		VO_045_27P_PKP		
CONT OP OPER_F_03	50/67G PKP	VO_048_50G_PKP		
CONT OP OPER_F_04	51/67G PKP	VO_049_51G_PKP		
CONT OP OPER_F_05	50/67P PKP	VO_051_50PH_PKP		
		VO_050_50PL_PKP		
CONT OP OPER_F_06	51/67P PKP	VO_053_51P_PKP		
CONT OP OPER_F_07	RECLOSE	OPERATION BIT 1		
		AR CLOSE BREAKER		
CONT OP OPER_F_08	TRIP	OPERATION BIT 2		
		VO_083_GENERAL_TRIP		
CONT OP OPER_G_01	81U/81O TRIP	VO_082_ALL_FREQUENCY_TRIP		
CONT OP OPER_G_02	27/59 TRIP	VO_079_ALL_OVERVOLTAGE_TRIP		
CONT OP OPER_G_03	50/67G TRIP	VO_068_50G_TRIP		
CONT OP OPER_G_04	51/67G TRIP	VO_067_51G_TRIP		
CONT OP OPER_G_05	50/67P TRIP	VO_059_50PL_TRIP		
		VO_058_50PH_TRIP		
CONT OP OPER_G_06	51/67P TRIP	VO_057_51P_TRIP		
CONT OP OPER_G_07	RCLS IN PROG	AR RCL IN PROGRESS		
CONT OP OPER_G_08	RCLS LOCKOUT	AR LOCKOUT		
CONT OP RESET_F_01	Not Configured			
CONT OP RESET_F_02	Not Configured			
CONT OP RESET_F_03	Not Configured			
CONT OP RESET_F_04	Not Configured			
CONT OP RESET_F_05	Not Configured			
CONT OP RESET_F_06	Not Configured			
CONT OP RESET_F_07	Not Configured			
CONT OP RESET_F_08	Not Configured			
CONT OP RESET_G_01	Not Configured			
CONT OP RESET_G_02	Not Configured			
CONT OP RESET_G_03	Not Configured			
CONT OP RESET_G_04	Not Configured			

CONT OP RESET_G_05	Not Configured			
CONT OP RESET_G_06	Not Configured			
CONT OP RESET_G_07	Not Configured			
CONT OP RESET_G_08	Not Configured			

SETPOINT>RELAY CONFIGURATION>LEDS				
LED ID	LED NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
LED01	TRIP	VO_083_GENERAL_TRIP		
LED02	50/51P TRIP	VO_019_PHASE_OVERCURRENT_TRIP		
LED03	50/51G TRIP	VO_069_GROUND_OVERCURRENT_TRIP		
LED04	27 TRIP	VO_073_27P_TRIP		
LED05	59 TRIP	VO_074_59P_TRIP		
LED06	PICKUP	VO_085_GENERAL_PKP		
LED07	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
LED08	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
LED09	27 PICKUP	VO_045_27P_PKP		
LED10	59 PICKUP	VO_046_59P_PKP		
LED11	79 READY	AR READY		
LED12	79 IN-PROG	AR RCL IN PROGRESS		
LED13	79 BLOCK	AR BLOCK BY LEVEL		
LED14	79 INHIBIT	AR CONDS INPUT		NOT
LED15	79 LOCKOUT	AR LOCKOUT		

SETPOINT>RELAY CONFIGURATION>PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
LED RESET INPUT	OPERATION BIT 3		
PH IOC1 HIGH A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 HIGH B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 HIGH C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 1		

PH IOC2 HIGH C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 LOW A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC1 LOW B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC1 LOW C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 2		

PH IOC3 LOW C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 2		
NEUTRAL IOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	
NEUTRAL IOC2 BLOCK	GROUP 2 BLOCKED		
	NEUTRAL DIR2 OP	NOT	
NEUTRAL IOC3 BLOCK	GROUP 3 BLOCKED		
	NEUTRAL DIR3 OP	NOT	
GROUND IOC1 BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR1 OP	NOT	
	LATCHED VIRT IP 3		
GROUND IOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR2 OP	NOT	
	LATCHED VIRT IP 3		
GROUND IOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR3 OP	NOT	
	LATCHED VIRT IP 3		
SENS GND IOC1 BLK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
	LATCHED VIRT IP 4		
SENS GND IOC2 BLK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
	LATCHED VIRT IP 4		
SENS GND IOC3 BLK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
	LATCHED VIRT IP 4		
PH TOC1 HIGH A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC1 HIGH B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC1 HIGH C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 5		

PH TOC2 HIGH B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 5		
NEUTRAL TOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	
NEUTRAL TOC2 BLOCK	GROUP 2 BLOCKED		
	NEUTRAL DIR2 OP	NOT	
NEUTRAL TOC3 BLOCK	GROUP 3 BLOCKED		
	NEUTRAL DIR3 OP	NOT	
GROUND TOC1 BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR1 OP	NOT	
	LATCHED VIRT IP 7		
GROUND TOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR2 OP	NOT	
	LATCHED VIRT IP 7		
GROUND TOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR3 OP	NOT	
	LATCHED VIRT IP 7		
SENS GND TOC1 BLOCK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
	LATCHED VIRT IP 8		
SENS GND TOC2 BLOCK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
	LATCHED VIRT IP 8		
SENS GND TOC3 BLOCK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
	LATCHED VIRT IP 8		
PHASE UV1 BLOCK	GROUP 1 BLOCKED		
PHASE UV2 BLOCK	GROUP 2 BLOCKED		
PHASE UV3 BLOCK	GROUP 3 BLOCKED		

NEG SEQ OV1 BLOCK	GROUP 1 BLOCKED		
NEG SEQ OV2 BLOCK	GROUP 2 BLOCKED		
NEG SEQ OV3 BLOCK	GROUP 3 BLOCKED		
THERMAL1 BLOCK	GROUP 1 BLOCKED		
THERMAL2 BLOCK	GROUP 2 BLOCKED		
THERMAL3 BLOCK	GROUP 3 BLOCKED		
PHASE DIR1 BLK INP	GROUP 1 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
PHASE DIR2 BLK INP	GROUP 2 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
PHASE DIR3 BLK INP	GROUP 3 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
NEUTRAL DIR1 BLK INP	GROUP 1 BLOCKED		
NEUTRAL DIR2 BLK INP	GROUP 2 BLOCKED		
NEUTRAL DIR3 BLK INP	GROUP 3 BLOCKED		
GROUND DIR1 BLK INP	GROUP 1 BLOCKED		
	LATCHED VIRT IP 10		
GROUND DIR2 BLK INP	GROUP 2 BLOCKED		
	LATCHED VIRT IP 10		
GROUND DIR3 BLK INP	GROUP 3 BLOCKED		
	LATCHED VIRT IP 10		
NEUTRAL OV1 HIGH BLK	GROUP 1 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV2 HIGH BLK	GROUP 2 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV3 HIGH BLK	GROUP 3 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV1 LOW BLK	GROUP 1 BLOCKED		
NEUTRAL OV2 LOW BLK	GROUP 2 BLOCKED		
NEUTRAL OV3 LOW BLK	GROUP 3 BLOCKED		
AUXILIARY UV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY UV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY UV3 BLOCK	GROUP 3 BLOCKED		
PHASE OV1 BLOCK	GROUP 1 BLOCKED		
	LATCHED VIRT IP 11		
PHASE OV2 BLOCK	GROUP 2 BLOCKED		
	LATCHED VIRT IP 11		
PHASE OV3 BLOCK	GROUP 3 BLOCKED		
	LATCHED VIRT IP 11		
AUXILIARY OV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY OV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY OV3 BLOCK	GROUP 3 BLOCKED		
NEG SEQ TOC1 BLOCK	GROUP 1 BLOCKED		
NEG SEQ TOC2 BLOCK	GROUP 2 BLOCKED		
NEG SEQ TOC3 BLOCK	GROUP 3 BLOCKED		
OVERFREQ1 BLOCK	GROUP 1 BLOCKED		
OVERFREQ2 BLOCK	GROUP 2 BLOCKED		

OVERFREQ3 BLOCK	GROUP 3 BLOCKED		
UNDERFREQ1 BLOCK	GROUP 1 BLOCKED		
UNDERFREQ2 BLOCK	GROUP 2 BLOCKED		
UNDERFREQ3 BLOCK	GROUP 3 BLOCKED		
SETT GROUPS BLOCK	Not Configured		
BROKEN CONDUCT1 BLK	GROUP 1 BLOCKED		
BROKEN CONDUCT2 BLK	GROUP 2 BLOCKED		
BROKEN CONDUCT3 BLK	GROUP 3 BLOCKED		
ISOLATED GND1 BLK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
ISOLATED GND2 BLK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
ISOLATED GND3 BLK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
SENS GND DIR1 BLK IP	GROUP 1 BLOCKED		
SENS GND DIR2 BLK IP	GROUP 2 BLOCKED		
SENS GND DIR3 BLK IP	GROUP 3 BLOCKED		
FWD PWR1 BLOCK	GROUP 1 BLOCKED		
FWD PWR2 BLOCK	GROUP 2 BLOCKED		
FWD PWR3 BLOCK	GROUP 3 BLOCKED		
PH TOC1 LOW A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC1 LOW B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC1 LOW C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 6		
PH TOC3 LOW A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 6		

PH TOC3 LOW B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC3 LOW C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 6		
DIR PWR1 BLOCK	GROUP 1 BLOCKED		
DIR PWR2 BLOCK	GROUP 2 BLOCKED		
DIR PWR3 BLOCK	GROUP 3 BLOCKED		
LOCKED ROTOR1 BLK	GROUP 1 BLOCKED		
LOCKED ROTOR2 BLK	GROUP 2 BLOCKED		
LOCKED ROTOR3 BLK	GROUP 3 BLOCKED		
THERMAL1 A RST	OPERATION BIT 4		
THERMAL1 B RST	OPERATION BIT 4		
THERMAL1 C RST	OPERATION BIT 4		
THERMAL2 A RST	OPERATION BIT 4		
THERMAL2 B RST	OPERATION BIT 4		
THERMAL2 C RST	OPERATION BIT 4		
THERMAL3 A RST	OPERATION BIT 4		
THERMAL3 B RST	OPERATION BIT 4		
THERMAL3 C RST	OPERATION BIT 4		
SYNCROCHECK BLK INP	Not Configured		
AR LEVEL BLOCK	CONT IP_F_CC8 (79 BLOCK)(CC8)		
	LATCHED VIRT IP 14		
AR PULSE BLOCK	Not Configured		
AR PULSE UNBLOCK	Not Configured		
AR INITIATE	VO_083_GENERAL_TRIP		
	CONT IP_F_CC7 (79 INITIATE)(CC7)		
	LATCHED VIRT IP 13		
AR CONDS INPUT	SYNCHK CLOSE PERM	NOT	NOT
	LATCHED VIRT IP 15		
BKR FAIL INITIATE	Not Configured		
RESET KI2t COUNTERS	OPERATION BIT 5		
RESET BKR COUNTERS	OPERATION BIT 5		
GROUP 1 ACT ON	Not Configured		
GROUP 2 ACT ON	Not Configured		
GROUP 3 ACT ON	Not Configured		
FAULT REPORT TRIGG	VO_083_GENERAL_TRIP		
CLEAR FAULT REPORTS	Not Configured		
DEMAND TRIGGER INP	Not Configured		
DEMAND RESET INP	OPERATION BIT 7		
FREEZE ENERGY CNT	Not Configured		
UNFREEZE ENERGY CNT	Not Configured		
RESET ENERGY CNT	OPERATION BIT 6		

SETPOINT>RELAY CONFIGURATION>OSCILLOGRAPHY				
DIGITAL CHANNELS	NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC

DIG_CHANNEL#1	TRIP	VO_083_GENERAL_TRIP		
DIG_CHANNEL#2	50/51P TRIP	VO_019_PHASE_OVERCURRENT_TRIP		
DIG_CHANNEL#3	50/51G TRIP	VO_069_GROUND_OVERCURRENT_TRIP		
DIG_CHANNEL#4	27 TRIP	VO_073_27P_TRIP		
DIG_CHANNEL#5	59 TRIP	VO_074_59P_TRIP		
DIG_CHANNEL#6	PICKUP	VO_085_GENERAL_PKP		
DIG_CHANNEL#7	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
DIG_CHANNEL#8	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
DIG_CHANNEL#9	27 PICKUP	VO_045_27P_PKP		
DIG_CHANNEL#10	59 PICKUP	VO_046_59P_PKP		
DIG_CHANNEL#11	79 READY	AR READY		
DIG_CHANNEL#12	79 IN-PROG	AR RCL IN PROGRESS		
DIG_CHANNEL#13	79 BLOCK	AR BLOCK BY LEVEL		
DIG_CHANNEL#14	79 INHIBIT	AR CONDS INPUT	NOT	
DIG_CHANNEL#15	79 LOCKOUT	AR LOCKOUT		
DIG_CHANNEL#16	Not Configured			
OSCILLO TRIGGER	OSCILLO TRIGGER	OPERATION BIT 8		
		VO_083_GENERAL_TRIP		

SETPOINT>RELAY CONFIGURATION>OPERATIONS			
OPERATION	OPERATION TEXT	SETTINGS	VALUE/SOURCE
Operation1	CLOSE BREAKER	INTERLOCK(LOGIC)	SYNCHK CLOSE PERM
		FINAL STATES AND(LOGIC)	BREAKER CLOSED
		FRONT KEY	I Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	1000
		CHANNELS	ALL
Operation2	OPEN BREAKER	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	BREAKER OPEN
		FRONT KEY	O Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	1000
		CHANNELS	ALL
Operation3	LEDS RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation4	THERMAL RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL

Operation5	BRK COUNTERS RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation6	ENERGY RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation7	DEMAND RESET	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation8	TRIGGER OSCILLO	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation9	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation10	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation11	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured

Operation12	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation13	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation14	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation15	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation16	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation17	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation18	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured

Operation19	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation20	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation21	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation22	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation23	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation24	Not configured	INTERLOCK(LOGIC)	Not configured
		FINAL STATES AND(LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured

SETPOINT>RELAY CONFIGURATION>CONTROL EVENTS				
EVENT	NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
EV1	Not Configured			
EV2	Not Configured			
EV3	Not Configured			
EV4	Not Configured			

EV5	Not Configured			
EV6	Not Configured			
EV7	Not Configured			
EV8	Not Configured			
EV9	Not Configured			
EV10	Not Configured			
EV11	Not Configured			
EV12	Not Configured			
EV13	Not Configured			
EV14	Not Configured			
EV15	Not Configured			
EV16	Not Configured			
EV17	Not Configured			
EV18	Not Configured			
EV19	Not Configured			
EV20	Not Configured			
EV21	Not Configured			
EV22	Not Configured			
EV23	Not Configured			
EV24	Not Configured			
EV25	Not Configured			
EV26	Not Configured			
EV27	Not Configured			
EV28	Not Configured			
EV29	Not Configured			
EV30	Not Configured			
EV31	Not Configured			
EV32	Not Configured			
EV33	Not Configured			
EV34	Not Configured			
EV35	Not Configured			
EV36	Not Configured			
EV37	Not Configured			
EV38	Not Configured			
EV39	Not Configured			
EV40	Not Configured			
EV41	Not Configured			
EV42	Not Configured			
EV43	Not Configured			
EV44	Not Configured			
EV45	Not Configured			
EV46	Not Configured			
EV47	Not Configured			
EV48	Not Configured			
EV49	Not Configured			
EV50	Not Configured			
EV51	Not Configured			
EV52	Not Configured			
EV53	Not Configured			
EV54	Not Configured			

EV55	Not Configured			
EV56	Not Configured			
EV57	Not Configured			
EV58	Not Configured			
EV59	Not Configured			
EV60	Not Configured			
EV61	Not Configured			
EV62	Not Configured			
EV63	Not Configured			
EV64	Not Configured			
EV65	Not Configured			
EV66	Not Configured			
EV67	Not Configured			
EV68	Not Configured			
EV69	Not Configured			
EV70	Not Configured			
EV71	Not Configured			
EV72	Not Configured			
EV73	Not Configured			
EV74	Not Configured			
EV75	Not Configured			
EV76	Not Configured			
EV77	Not Configured			
EV78	Not Configured			
EV79	Not Configured			
EV80	Not Configured			
EV81	Not Configured			
EV82	Not Configured			
EV83	Not Configured			
EV84	Not Configured			
EV85	Not Configured			
EV86	Not Configured			
EV87	Not Configured			
EV88	Not Configured			
EV89	Not Configured			
EV90	Not Configured			
EV91	Not Configured			
EV92	Not Configured			
EV93	Not Configured			
EV94	Not Configured			
EV95	Not Configured			
EV96	Not Configured			
EV97	Not Configured			
EV98	Not Configured			
EV99	Not Configured			
EV100	Not Configured			
EV101	Not Configured			
EV102	Not Configured			
EV103	Not Configured			
EV104	Not Configured			

EV105	Not Configured			
EV106	Not Configured			
EV107	Not Configured			
EV108	Not Configured			
EV109	Not Configured			
EV110	Not Configured			
EV111	Not Configured			
EV112	Not Configured			
EV113	Not Configured			
EV114	Not Configured			
EV115	Not Configured			
EV116	Not Configured			
EV117	Not Configured			
EV118	Not Configured			
EV119	Not Configured			
EV120	Not Configured			
EV121	Not Configured			
EV122	Not Configured			
EV123	Not Configured			
EV124	Not Configured			
EV125	Not Configured			
EV126	Not Configured			
EV127	Not Configured			
EV128	Not Configured			

SETPOINT>RELAY CONFIGURATION>SWITCHGEAR				
SWITCHGEAR	SETTING	VALUE/SOURCE	SIGNAL LOGIC	SOURCE LOGIC
SWITCHGEAR 1	CONTACTS	52b		
	OPENING TIME	1000		
	CLOSING TIME	1000		
	CONTACT A SOURCE	N/A		
	CONTACT B SOURCE	CONT IP_F_CC1 (52b)(CC1)		
	OPEN TEXT	52 OPEN		
	ALARM	NO		
	CLOSED TEXT	52 CLOSE		
	ALARM	NO		
	ERROR 00 TEXT	52 ERROR		
	ALARM	N/A		
	ERROR 11 TEXT	52 UNDEFINED		
	ALARM	N/A		
	OPENING INIT	OPERATION BIT 2		
	CLOSING INIT	OPERATION BIT 1		

SWITCHGEAR 2	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 3	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 4	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		

SWITCHGEAR 5	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 6	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 7	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		

SWITCHGEAR 8	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 9	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 10	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		

SWITCHGEAR 11	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 12	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 13	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		

SWITCHGEAR 14	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 15	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
SWITCHGEAR 16	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		

FIRMWARE VERSION	BOOT PROGRAM VERSION	CHANGES DESCRIPTION	MODELS	DATE
1.00	2.00	First version of the product (Basic Model F1G0) Full protection scheme	F650BABF1G0HI	June 28th 2002
1.11	2.00	New model F2G0 (inputs and outputs board type 2)	F650BABF2G0HI	October 14th 2002
1.13	2.20	Snapshot Events included (New and All) Oscillography up to 4 records. Maximum 70 cycles at 64 samples per cycle, trip programmable via PLC. Broken Conductor protection function included. Boot program updated through F650PC program	ALL	December 20th 2002
1.14	2.20	DNP 3.0 Level 2 protocol included, over TCP/IP and UDP/IP IRIG_B synchronization	ALL	January 22nd 2003
1.20	2.25	Programmable Graphical display Calibration included to improve measurement accuracy	ALL	January 28th 2003
1.30	2.25	Sensitive ground directional unit Isolated Ground directional unit (in 5th current transformer) Energy measurements	ALL	March 31st 2003
1.31	2.25	Enhancements in 60 Hz measurements Extended Settings Range in Negative Sequence Overcurrent function (46)	ALL	April 9th 2003
1.33	2.30	Forward Power function (32FP) Demand	ALL	May 9th 2003
1.44	2.30	51PL function included (besides existing 51PH) Control Events Alarms ModBus over TCP/IP	ALL	July 24th 2003
1.48	2.30	Changes in 67 units in reverse mode ModBus TCP/IP enhancement	ALL	September 5th 2003
1.50	2.30	**PROTECTION** The following operation curves have been added to F650 functionality: IEC Long-Time Inverse IEC Short-Time Inverse ANSI Extremely Inverse ANSI Very Inverse ANSI Normally Inverse ANSI Moderately Inverse Rectifier Curve User Curve A/B/C/D - Flex Curve™ Note: User Curves allow the user to program any non-standard curve type by selecting, point by point, the Operation time. **HARDWARE** Voltage Range:Voltage Metering Range expanded from (2 to 200 Volts) to (2 to 275V) CIO Module: For those applications requiring a high number of inputs and outputs, F650 units can be connected to a CIO module (Remote CAN Bus I/O module) for using up to 2 additional boards. **COMMUNICATIONS** ModBus Protocol: ModBus User Map Virtual Inputs (control over internal logic variables, which can be used in the configurable logic). DNP 3.0 Protocol New Metering scale factors Switchgear bits mapped to binary points Possibility of restricting the binary points map by setting **USER INTERFACE** HMI Configurable Main Screen: The main screen offers the possibility to select the initial logo, a simplified Metering screen showing primary values, or both. Snapshot Events: Possibility of viewing snapshot events from the relay display in models without graphical display.	ALL	October 31st 2003

FIRMWARE VERSION	BOOT PROGRAM VERSION	CHANGES DESCRIPTION	MODELS	DATE
1.61	2.35	**COMMUNICATIONS** Configuration: LED Reset by communications using the configurable logic **METERING** Monitoring of phasor measurements in module and argument REGISTER Snapshot Events: Possibility of reading the Snapshot events in Binary and ASCII format via ModBus Oscillography: The oscillography function has been improved to offer the possibility of creating up to a maximum of 20 oscillography records, with possibility to create concatenated oscillographies. Oscillography records can be obtained via communications using serial messaging (ModBus) or Ethernet (TCP/IP or TFTP). Fault Report: This version incorporates the tool to visualize and store the information from the last ten faults produced. This report can be shown on the relay display. The fault report will be available on the relay display and via communications, either on ModBus (serial) or TCP/IP. Data Logger: It allows registering 16 channels among all the available analog measures in the relay. The information provided by the data logger can be obtained via TCP/IP. **USER INTERFACE** Fault Report screen on HMI: Fault report information on display, selectable by setting **WEB SERVER** Web server tool has been upgraded to provide visualization of: Snapshot Events Control Events Alarms Oscillography Fault report Data Logger Metering	ALL	April 30th 2004
1.62	2.35	Internal file management enhancement. IP Address maintenance after firmware upgrading. Latched Virtual Inputs maintenance after powering off and on the relay.	ALL	June 24th 2004
1.70	2.35	Multilingual relay (French and English available)	F650BABF1G0HIF F650MFDF2G1LOF F650MFCF1G1LOF	August 5th 2004

FIRMWARE VERSION	BOOT PROGRAM VERSION	CHANGES DESCRIPTION	MODELS	DATE
1.72	2.35	**COMMUNICATIONS** Multimaster DNP (3 masters) **METERING** Measurement enhancement **PROTECTION** Sensitive Directional Power unit is included (32) **REGISTER** Snapshot Events: Possibility to be enabled and disabled by setting. In previous versions snapshot event generation was enabled by default and fixed for all elements. Using the “config file converter” tool the snapshot event settings will be included but to their default value (disabled), user must set the snapshot event generation to the desired value. Notice that having snapshot event to disabled no internal signals will be recorded in the snapshot event buffer. **USER INTERFACE** HMI Enhanced HMI meeting EnerVista 650 Setup structure. Multilingual Option available: The relay can be ordered in languages different from English, the relay always has English as default Languages Available now: French/English (F in ordering code request) English/English (former ordering code) **ENERVISTA 650 Setup** Multilingual unit (French and English available). WEB SERVER Multilingual visualization of snapshot events, control events, oscillography, fault recorder, data logger, metering.	ALL	November 26th 2004
1.80	2.35	**USER INTERFACE** **HMI:** New languages available: Russian and Spanish. Russian/English (P in ordering code, basic display only) Spanish/English (S in ordering code) **ENERVISTA 650 Setup** New languages available: Russian and Spanish. Passwords included in EnerVista 650 Setup (different from the HMI ones). **WEB SERVER** Multilingual visualization of snapshot events, control events, oscillography, fault recorder, data logger, metering. New languages available: Russian and Spanish. Visualization Enhancement. **COMMUNICATIONS** Modbus TCP communications enhacement. External CAN interruptions management enhancement. **METERING** Decimal point included in PT and CT ratios. Power Factor measurement enhancement. **PROTECTION** Function 48 included. I2/I1 setting to select the minimum inhibition current level of the unit . TOC operation level at 1.03 times the pickup (1.05 in previous releases). Neutral units measures management enhancement. Startup Enhancement. **REGISTER** Time Stamp for switchgear control events enhancement.	ALL	March 1st 2005

FIRMWARE VERSION	BOOT PROGRAM VERSION	CHANGES DESCRIPTION	MODELS	DATE
2.00	3.00	**HARDWARE:** New options for Real Serial Comm. Board 1: C: Cable remote CAN bus I/O M: RS485 + cable remote CAN bus I/O New options for Rear Ethernet Comm. Board 2: E: Redundant 10/100 Base TX New options for I/O Boards (available for slot G and CIO modules): 4: 32 digital inputs 5: 16 digital inputs + 8 analog inputs **COMMUNICATIONS** Protocol IEC 61850 GSSE Client/server implementation. SNTP Synchronization (Clock time obtained over an Ethernet network)	ALL	June 30th, 2005
1.82	4.00	File system management enhancement in boot code 4.00 Measurements enhancement in 1.82 firmware version	All models, excepting Options 4 and 5 for I/O boards. Option 6 for IEC 61850 protocol	October 17th 2005
2.20	4.00	**USER INTERFACE** **ENERVISTA 650 Setup·** - Data Logger visualization changes.· - File name available in "Config file converter" tool. **COMMUNICATIONS·** - DNP Scale factor correction.· - IRIGB synchronization: - Date and time synchronization available. - 980 ms delay correction. **INPUTS/OUTPUTS·** - Inputs Activation/Deactivation correction.· - Voltage threshold setting range from 20 to 230 Vdc.· - Debounce time settings: - Timestamp before debounce time - Setting range from 1 to 50 ms. **METERING·** - Power calculations using ARON method.· - New measurements provided when using Delta connection and VN as auxiliary voltage input: - Neutral voltage available. - Phase to ground voltages available. - Single phase power measurements available. **PROTECTION·** - Neutral, ground and sensitive ground directional units available with delta connection and VN as auxiliary voltage input.· - Minor changes in Forward Power elements. **REGISTER·** - Ground current available in Fault report.· - Corrected 150 ms delay in Snapshot events measurements.	All models, excepting Options 4 and 5 for I/O boards. Option 6 for IEC 61850 protocol	November 25th 2005

GE MULTILIN RELAY WARRANTY

GE Power Management, S.A. (GE Multilin) warrants each relay it manufactures to be free from defects in material and workmanship under normal use and service for a period of 24 months from date of shipment from factory.

In the event of a failure covered by warranty, GE Multilin will undertake to repair or replace the relay providing the warrantor determined that it is defective and it is returned with all transportation charges prepaid to an authorized service center or the factory. Repairs or replacement under warranty will be made without charge.

Warranty shall not apply to any relay, which has been subject to misuse, negligence, accident, incorrect installation, or use not in accordance with instructions nor any unit that has been altered outside a GE Multilin authorized factory outlet.

GE Multilin is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a relay malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Multilin Standard Conditions of Sale.